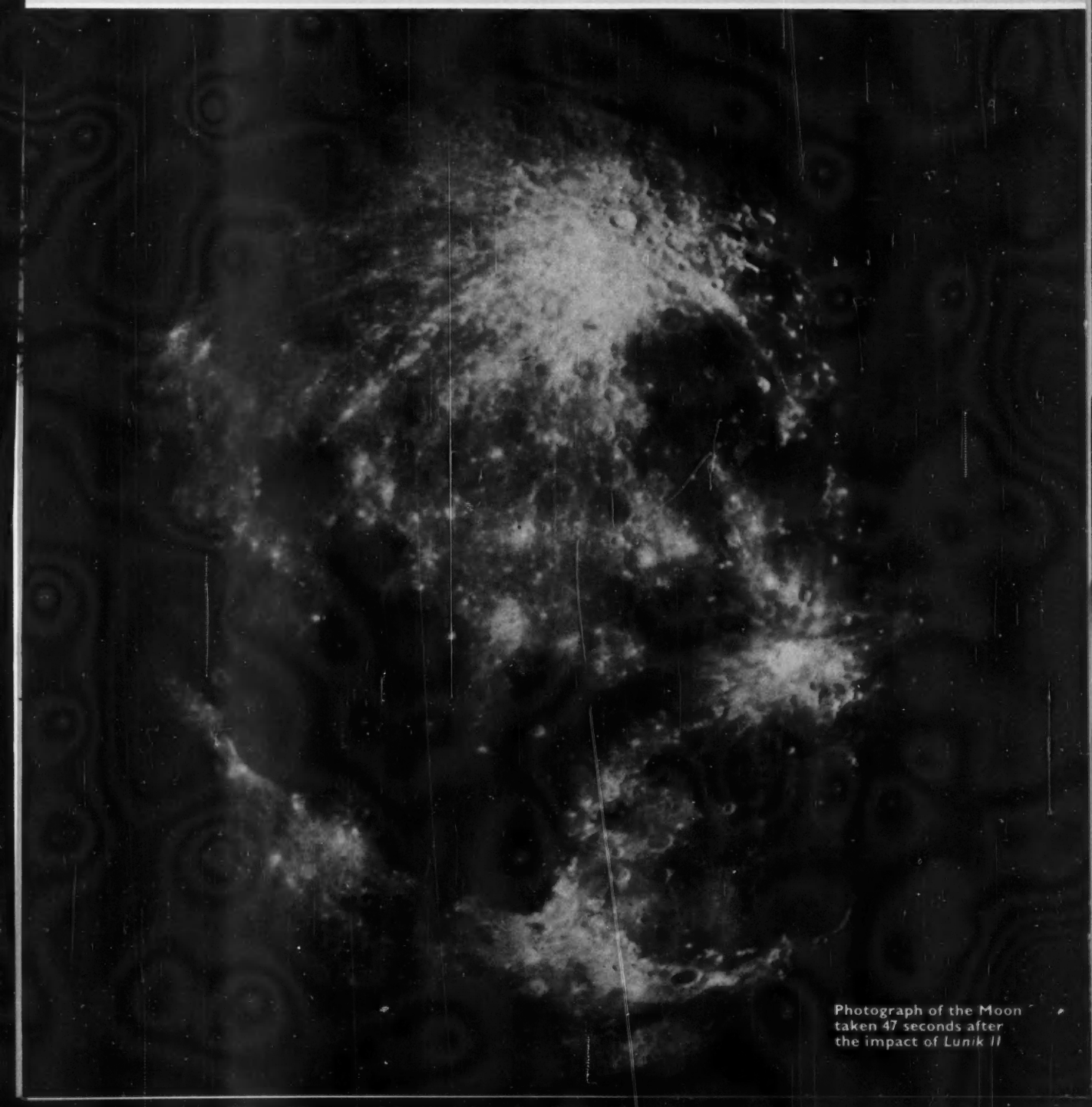
# DISCOVERY

THE MAGAZINE OF SCIENTIFIC PROGRESS

OCTOBER 1959 2/6



Photograph of the Moon taken 47 seconds after the impact of *Lunik II*

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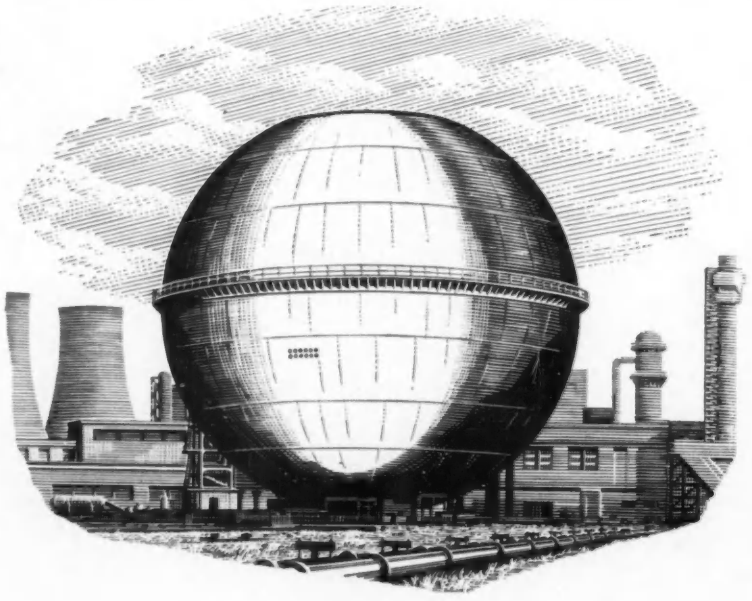

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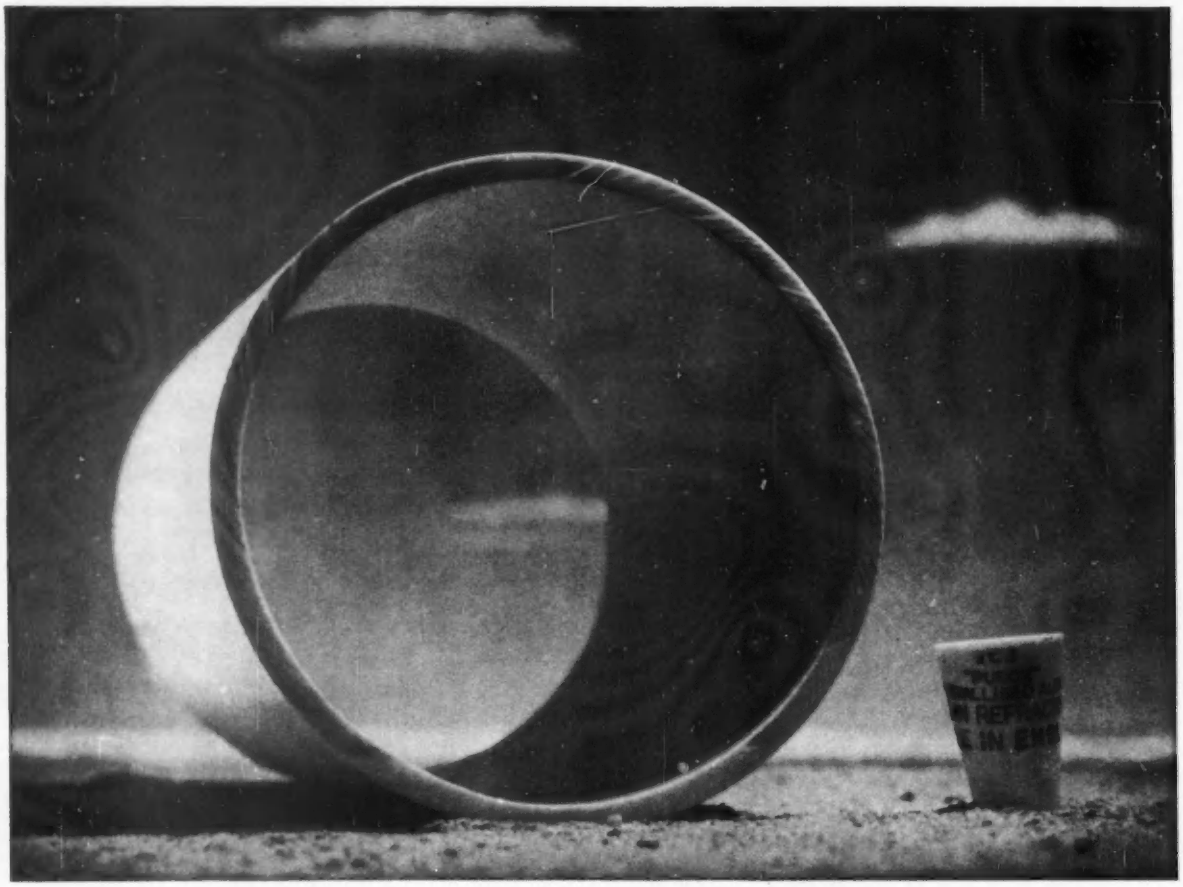

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# DISCOVERY

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*Editor*
Anthony R. Michaelis, PH.D., B.SC.

*Editorial Office*
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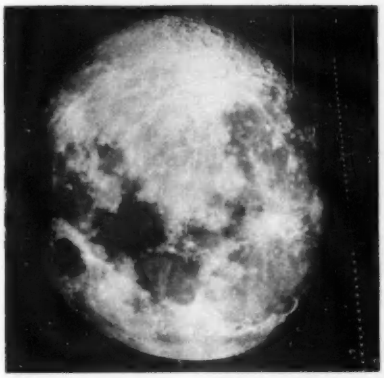
### OUR COVER PICTURE



was taken by Mr G. A. Hole of Brighton. He comments "Ten minutes before published contact time visual observation on specified area was started using a reflecting telescope of 24 in. with 300× power. At one minute past published impact time nothing had been seen, so change over to plate holder was made and four exposures were taken in sequence. Visual observations were resumed until the radio reported that the rocket had landed and then observations ceased. Actual impact occurred 22.02.23 hours GMT and this picture was secured just 47 seconds later, at which time surface-dust might possibly still be disturbed. It is this fact alone that makes the photograph valuable. Careful comparison with similar photographs taken before the impact may show something; in any case the impact area must be on the plate somewhere. It will be interesting and perhaps of value, to see if it can be spotted."

The 24-in. telescope can show objects 300 to 350 yds. diameter on the Moon, so it might have been possible to see the actual impact, providing it produced a mark bigger than this. In the absence of air, considering the Moon's gravity, and at impact velocity, it was not unreasonable to try to see it. As it turned out Mr Hole was changing from visual to plate holder when impact occurred. A close visual check will be made when the terminator passes over the area again. Until then no one can hope to find it.

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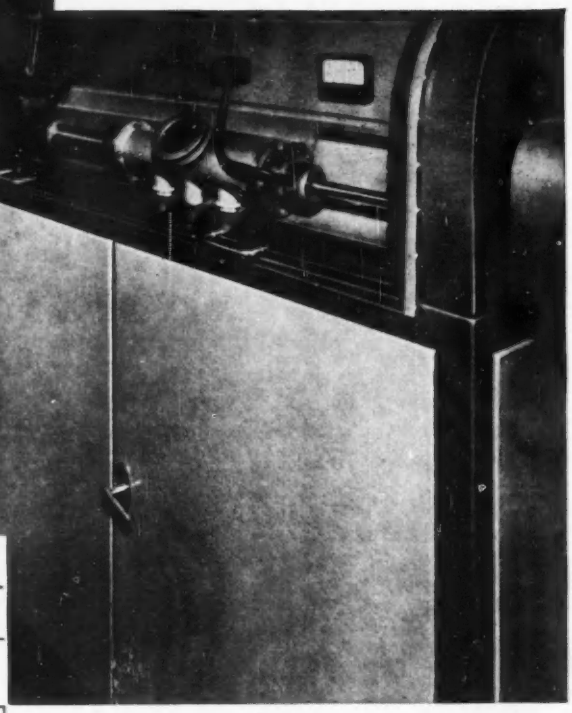

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# THE PROGRESS OF SCIENCE

## SCIENCE AND WHITEHALL

Whether the British Civil Service will continue to enjoy its unrivalled reputation and pride of place depends on how far it can adapt itself to changing conditions and circumstances, not least those thrown up by the impact of this scientific age. Among the most decisive instruments in meeting this contemporary challenge should be our Scientific Civil Service: hence the importance of studying the problems besetting this recently formed arm of our administration, for they are indeed basic to the progress of science in this country.

The Scientific Civil Service was one of the most important items of post-war Civil Service reorganisation. The creation within the administration of a unified structure embodying three linked scientific classes parallel to the general classes appeared to reflect our legislators' realisation that science had at last "arrived". How far have these hopes been realised? True, 15,000 scientists are today employed in the Civil Service compared with 3500 before the war: nevertheless, the staffing position is far from satisfactory. There are two main points of controversy—that of "relativities" and that of the career structure. Should, for example, scientists enjoy parity of pay with the administrative class? Many scientists feel that they should. The Treasury, perhaps anxious to preserve the prestige enjoyed by the administrative class, base their resistance on the doctrine of "fair comparisons", and argue that the remuneration of scientists should not be tied to the pay of administrators, but should reflect the pay of scientists outside the Civil Service. Officialdom suggests that in a more scientific world this will work out to the benefit of scientists: sceptics point out that the State as the major employer of scientists sets the tune not only inside but also outside government service. The £12 10*s*. per week salary offered by Manchester University for a "driver" for the Jodrell Bank telescope is hardly reassuring. The hope that the top scientific posts in industry could act as pace-setters has not yet been sufficiently realised, and in practice some of the nation's best scientific brains are all too often lost to commerce or emigration.

The issue of the career structure is perhaps even more serious. The promotion pyramid is far bigger in the administrative than in the scientific class and potentially justifiable steps to improve the "relativities" in the earlier years of scientists' careers have been avoided. Thus, all too often the scientist in the prime of his research creativeness is underpaid, while if he were to seek in the administrative class that promotion denied him in his own scientific grade, it might only be to find that he is too old to learn a new type of job. Sixteen years have passed since the Barlow Committee urged "a more frequent transfer of suitable scientists to the administrative class", but little has happened. Indeed, within the higher Civil Service the dominance of arts graduates from the older universities seems to have strengthened rather than diminished, and even if in the course of time, as hoped by the Royal Commission on the Civil Service, more scientists emerge who earn as much as their Permanent Secretaries, it is the administrators who set the tone, values, and policy within a department.

At first sight the organisation, as opposed to the staffing, of what we broadly term the Scientific Civil Service has been a less controversial operation. The framework for scientific work has grown up empirically and extreme solutions have been avoided. On the one hand, it would have been possible at the cost of excessive centralisation, to have a comprehensive Ministry of Research, responsible for every piece of research done by the Government: at the other extreme, scientific activities could be viewed as the separate responsibilities of each administrative department concerned. In practice, where the Government is the client, the work has been done by the departments: where the research is used more widely, special agencies, such as the DSIR, the MRC, and the ARC, have been set up over the years. This structure, to quote the first Annual Report of the Advisory Council on Scientific Policy, incorporates two basic principles, the one, in our opinion, eminently laudable, the other perhaps less so. One is a concept, essential to scientific freedom, that "the research [authorities] . . . should be free to initiate background research when they [think] fit". The other is a proposition that "the executive department should be responsible for identifying problems requiring research, settling their order of priority", and so on, which while nominally straightforward, inevitably raises in its acutest form the question of the nature of the scientific advice which is available to Ministers.

Of course, it is in theory the Minister who decides, but in practice he can do very little. Indeed, we doubt whether the position of a departmental Minister is in this particular very different from that of the Lord President of the Council. Thus, the Lord President, in his capacity of chairman of all the specialist scientific sub-committees of the Privy Council, does not act as some special Minister of Science but rather ensures a necessary minimum of control coupled with a high degree of autonomy for our scientific institutions. If he sought to intervene in detail, the question would naturally arise: by what criterion would this be? A recent remark of the Prime Minister's in outlining the Government's policy towards space research is revealing, not so much for what it says but for the attitude it conveys. "I am not, by nature or, I am afraid, by education, very favourably inclined to swallow all that the scientists tell me, because, alas, I do not understand it." Most politicians, with some exceptions, would, we fear, subscribe in their franker moments to the Prime Minister's views. Effectively then the supreme management of science in government is delegated from our elected leaders to their advisors. It is not least for this reason that the training and outlook of the administrative grade of our Civil Service is so vital, and it is not in any sense of carping criticism that we repeat our plea for the change of attitude, especially in the universities, which alone can bring humanism to the scientist and a scientific spirit to the administrator.

The recent announcement by both the Conservative and Labour parties that they intend to create a "Minister for Science" is not sufficiently explicit to sway the votes of scientists. If an eminent scientist could thus make his views felt at Cabinet level, as Lord Cherwell did, the announcement is to be welcomed. If it should mean a strengthening of "official science" against the opinions of "academic science", the appointment of such a minister may not be in the long-term interests of this country.

## FUEL CELL DEVELOPMENTS

The fuel cell has become almost like the philosophers' stone, the magic substance (always to be found just round the corner) which would turn lead into gold. Any large-scale nuclear research station is nowadays equipped to transmute elements as a routine operation: but the twin possibilities offered by the development of a practicable and economic fuel cell elude us just as artfully as the secret of the transmuting stone eluded our philosophic ancestors.

A successful fuel cell would enable us to break out of the grip of the Carnot cycle, which seems effectively to prevent us from burning any sort of fuel to generate electricity at an efficiency greater than about 45%.

The fuel cell could also solve the increasingly serious problem of providing a means to store electricity on a scale comparable with the total demand on a national grid system. In this way the huge sums poured into the construction of steam, hydro, and nuclear power plants, which are at present utilised fully for only 47% of their available time on the average, could be made to show a much greater return.

The fuel cell, to justify its name, must convert fuel—principally coal or oil—directly into electrical energy. In most of the designs so far put forward, in Britain, America, Germany, and the U.S.S.R., the approach has been on one or two lines.

Attempts have been made to use the direct method: that is, to employ the carbon fuel in the cell itself, for example in the Bischoff design (West Germany), where an electrolyte of clay impregnated with sodium carbonate made into a hollow cylinder which carries the carbon fuel is used, oxygen (forming the other electrode) being blown through a surrounding layer of magnetite.

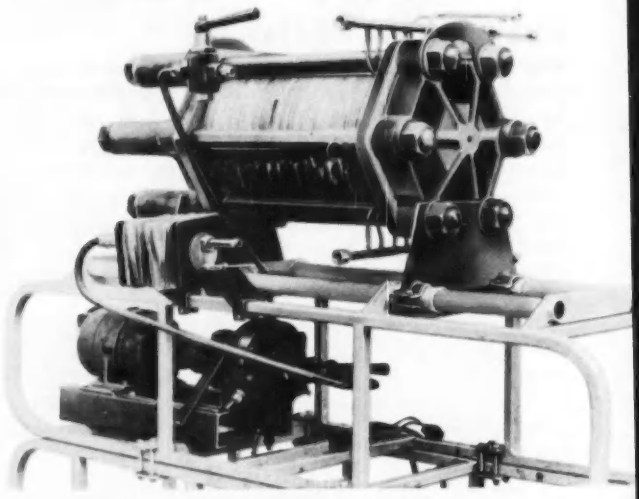
The Bacon cell belongs to the indirect class of cell, which follows the basic principle of the ordinary primary battery such as the Leclanché cell used in torches. Instead of the Leclanché electrodes of carbon and zinc, the electrodes of the Bacon cell are the two gases, hydrogen and oxygen.

The hydrogen can be made from coal by the water-gas process, whereby steam is passed over red-hot coke, and oxygen could be provided from the air.

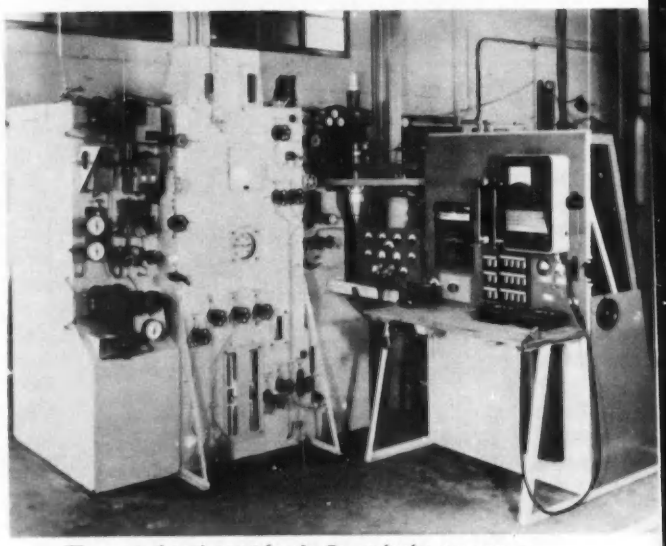
The Bacon cell consists of two flat, circular disc electrodes, each made of porous sintered nickel. The electrolyte is potassium hydroxide (KOH) of 40% concentration, and exists in a thin layer, about 2 mm. thick, between the electrode plates.

The "liquid" side of the plates is covered with a thin layer of a pore-size smaller than the main substance. The back of the plate is closed in so that gas under pressure can be forced into the large pores, while the size of the smaller pores prevents the gas bubbling through into the electrolyte, owing to the surface tension effect.

The hydrogen electrode is the negative plate of the cell, the oxygen forming the positive. The cell operates at a temperature of about 200°C. The voltage across it is about 0·8 V, and the current drawn can be very large—as much as 300 amp. Increased gas pressure obviously provides increased energy input, and pressures lying between 300 and 600 lb./sq. in. are used, the average running figure being 400 lb./sq. in. With this pressure the life of the electrode plates was stated to be indefinitely long.



The Bacon hydrogen-oxygen fuel cell.

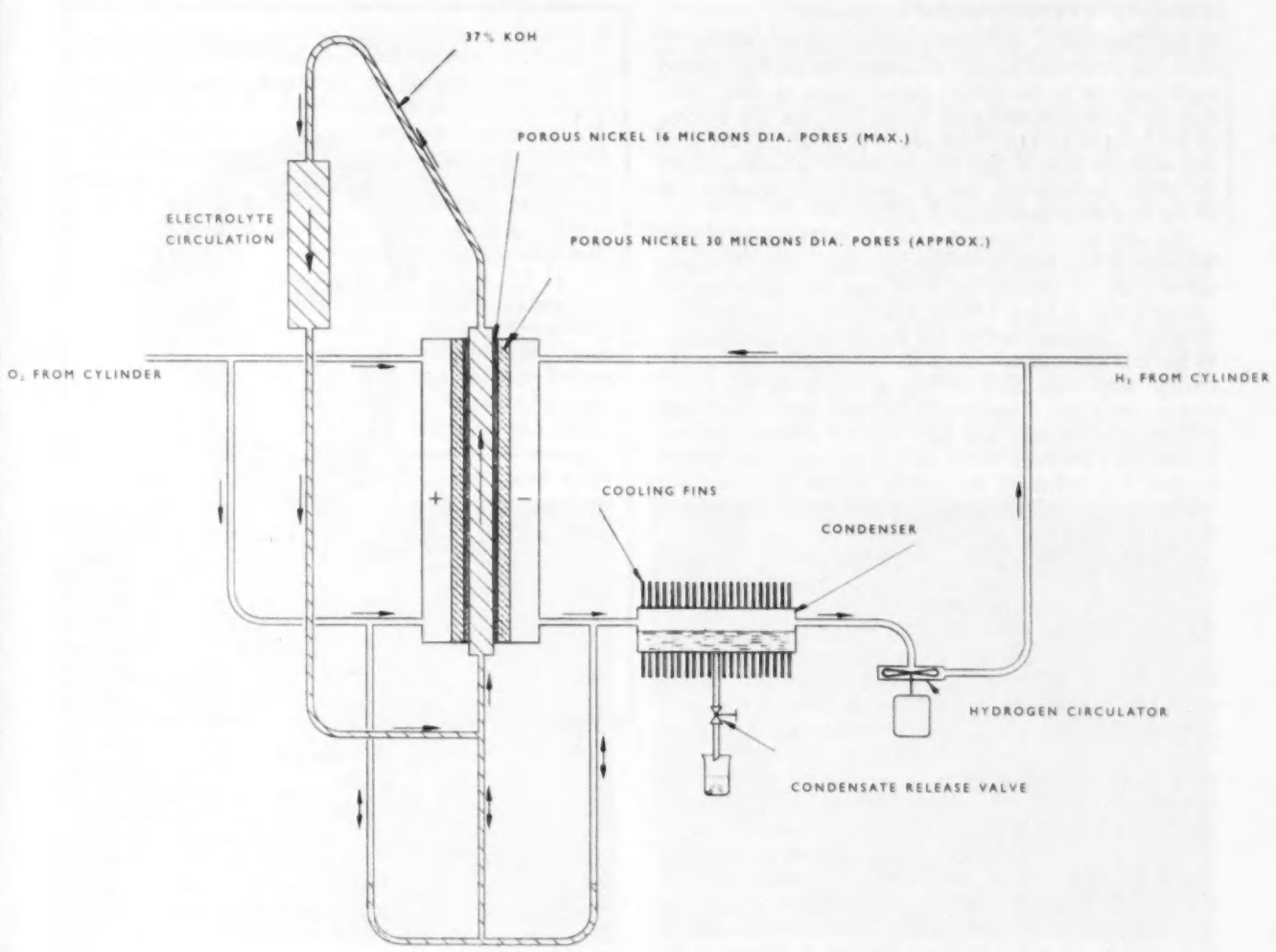


The control equipment for the Bacon hydrogen-oxygen fuel cell.

The cell assembly demonstrated on load was made up of a stack of 40 cells in series, and was about 24 in. long, 15 in. wide, and 18 in. high. It had an output of 5 kW at 24 V, and an efficiency of 50% to 60%, depending on the load. The power per unit volume (of the cell alone) was 10·7 kW/cu. ft., and the power per unit weight was 9·2 W/lb.

A disadvantage of the present purely experimental set-up is that the control cabinet is larger than the battery. It contains servo-operated valves to regulate and balance the gas flow, and temperature and output controls and meters. So far, it does not appear possible to reduce the size of fuel cell assembly below the 2-kW level, and here the space occupied by cell assembly, the control cabinet, and the gas cylinders would nearly fill an ordinary family saloon car.

An ideal application would be on an experimental rail




Hydrogen-oxygen cell.

car, where the whole of the luggage compartment could be given over to the cell; but smaller designs, when developed, may have important applications in satellites and missiles. It seems likely that the Bacon fuel cell would be a very useful power source for any vehicle travelling on the moon. A solar-power-operated electrolytic cell could decompose water into hydrogen and oxygen during the lunar "day". This hydrogen and oxygen could be used to drive the vehicle and as its exhaust would only be water this could be recycled and used again in the electrolytic cell; thus the hydrogen and oxygen are used as energy stores for transport during "day" and "night" on the moon.

The ten years of research, first at Cambridge University (under the auspices of the Electrical Research Association and the Ministry of Power) and later at Marshall of Cambridge Electronics Ltd, under a development contract for the National Research Development Corporation Ltd, have brought the fuel cell to the stage where a practical application can confidently be sought, especially in the field of traction: but so far no British industrial interests have offered to provide means whereby the cell can be evaluated under commercial working conditions. In America, however, in spite of considerable work on fuel cell designs in a number of centres, a private corporation has taken out a licence to manufacture the Bacon cell, and has already supplied a number of units to the United States Air Force.

Although at the moment the Bacon cell seems to have reached the most advanced stage, work in this field has been reported from the U.S.S.R. and the U.S.A., and also from another source in Britain. The Ministry of Power, in conjunction with Shell Research Ltd, are working on a cell using hydrocarbon vapour and air, and employing a molten electrolyte supported in a sheet of porous magnesia. When development has proceeded further, it is hoped that this cell can use a wider range of industrial gases and distillate fuels.

Perhaps in the next decade we shall see giant banks of fuel cells alongside our nuclear stations, using the gases electrolytically produced at off-peak hours to give back power when needed, and so making the nuclear plants at least twice as economically justifiable as they are now.

## ROBERT STEPHENSON (1803–59)

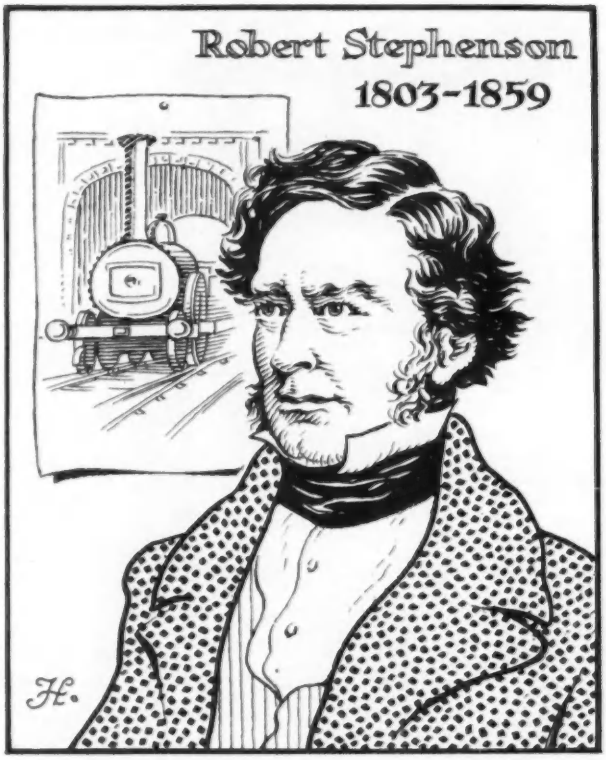
Robert Stephenson, who died a century ago on October 12, 1859, did more than anyone to develop the railway systems made possible by his father's pioneer work on steam locomotion. In this present year, which has seen the opening of the great St Lawrence Seaway, it is fitting that his work in connexion with bridges should also be remembered, for the bridge he built over the St Lawrence at Montreal was at one time the longest in the world.

The only son of George Stephenson (1781–1848), Robert Stephenson was born at Willington Quay, near Newcastle upon Tyne, on October 16, 1803, and after attending the village school at Long Benton, went to Bruce's Academy in Newcastle. Anxious that his son should not be handicapped by the lack of education which had affected his own career, George Stephenson kept the boy at school till the age of sixteen, made him a member of the Newcastle Literary and Philosophical Society, and sent him for a short while to Edinburgh University. After leaving the university, Robert assisted his father in his survey of the Stockton and Darlington Railway, which was opened for traffic September 27, 1825.

A breakdown in health caused him to seek a change of climate, and having been offered the post of superintendent of some gold and silver mines in Colombia, he left for South America in June 1824. His return to England was hastened by the difficulties which had arisen in the locomotive factory at Newcastle and coincided with the dispute over the most suitable type of traction for the Liverpool and Manchester Railway. Resuming his work at Newcastle, Stephenson took over the building of the *Rocket*, surmounting the chief obstacle—a method of securing the tubes to their plates—and effecting numerous improvements on the original design. During the next six years he was fully employed as assistant to his father, gaining considerable experience of the problems involved in locomotive and railway construction. Following the passing of an Act sanctioning the London and Birmingham Railway in 1833, he was appointed engineer in charge of the scheme. Its successful conclusion and the distinction of having made the first railway into the capital was not lightly won, for the natural hazards were formidable, the construction of the Blisworth cutting and the long Kilsby tunnel, which was threatened with flooding, calling for special skill.

The London and Birmingham line was opened in 1838, and Stephenson devoted the remainder of his life to railway engineering. Many railways at home and abroad were built under his personal supervision, and he was consulted over the plans of several others. At home he played a leading part in the "battle of the gauges", in which his principal opponent was his friend and rival, Isambard Kingdom Brunel (see DISCOVERY, 1959, vol. 20, No. 9, p. 376), and he was a strenuous defender of the steam locomotive against the alternative system of "atmospheric" railways.

It is as a great builder of bridges that Stephenson is chiefly remembered. The high-level bridge across the Tyne at Newcastle and the Victoria bridge at Berwick were fine early achievements, but it was his masterly plan for bridging the Menai Straits which brought him the most enduring fame. The construction of the Chester and Holyhead line, authorised in 1844, involved much thought and planning. Previously the road from London to Holyhead, so important as a link between the metropolis and Dublin, had been dependent on the beautiful suspension bridge built across the Straits by Thomas Telford between 1818 and 1825. Stephenson eventually decided upon the tubular girder type of bridge to carry the railway across the Straits. The bridge, which was a great engineering achievement, was opened on March 5, 1850. Other noteworthy examples of bridges built by Stephenson were those carrying the Egyptian Railway across the Nile at Benah and Kaffre Azzayat and the Victoria Bridge over the St Lawrence.




Specially drawn for DISCOVERY by Frank Horrabin.

Stephenson was Member of Parliament for Whitby from 1847 until his death, representing the Conservative and Protectionist interest, but his interventions in the House were practically confined to those occasions when engineering matters were discussed, as when he opposed the Suez Canal scheme.

Stephenson was accorded many honours. He was elected F.R.S. in 1849, was president of the Institution of Civil Engineers from 1856–7, and received an honorary D.C.L. from Oxford University in 1857. Foreign recognition was shown by bestowal of the Order of Leopold by the King of the Belgians, and his investment with the Grand Cross of St Olaf of Norway. The council of the French Exhibition of 1855 awarded him the Great Gold Medal of Honour for his invention of the tubular-plate system of bridge construction.

In 1859, Stephenson, who had suffered ill health for a long time, was taken seriously ill, and died on October 12 of an "affection of the liver" associated with "further internal disease". He was buried in Westminster Abbey.

## RESEARCH FILM OF GRAPHITE ATOMS

Scientists working at Atomics International, a division of North American Aviation, have recently recorded by cinemicrography the dislocations, or imperfections, in the atomic arrangement of the structure of graphite, an important material used in nuclear reactors.

Dislocations affect the physical properties of materials, influencing the strength, conductivity, and other mechanical properties. The discovery has established a basis for continued studies, which may indicate new practical applications of the material. It is being documented by additional research.

Graphite is used as a moderator in several nuclear reactors, including the Sodium Reactor Experiment (SRE), an atomic power project conducted by the U.S. Atomic Energy Commission. The SRE has produced heat for the generation of nearly 2,600,000 kWh of electricity for commercial use in southern California during several power runs.

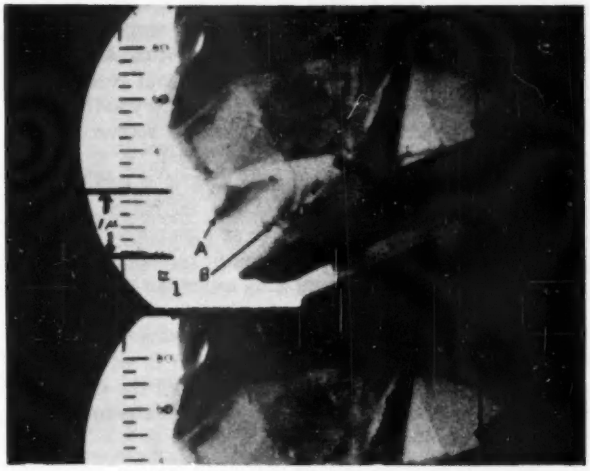
Observation of dislocations in graphite were made by Dr Alexander Grenall at a recent meeting of the Electron Microscope Society of America at Santa Monica, California. Dislocations and their nature were shown by an electron microscope.

Latest photographic equipment was used to record the movements of dislocations in graphite crystals. A 16-mm. motion-picture camera was mounted so that the lens was near the microscope's fluorescent screen. A special lens of $f/0{\cdot}95$ and high-speed film made possible the film recording.

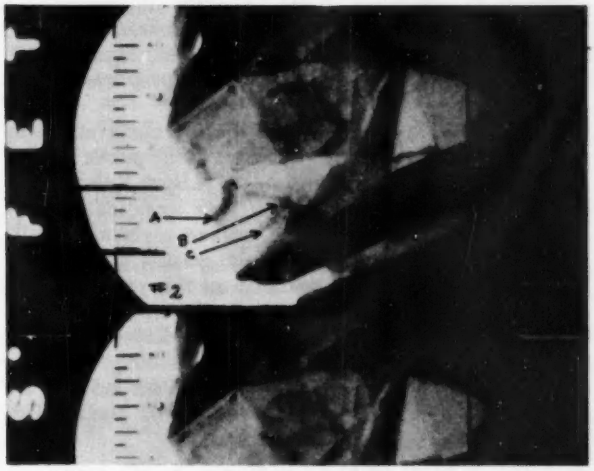
Graphite specimens were photographed at magnifications of 12,500 and 25,000. Only the light from the microscope screen was utilised in the procedure.

Dr Grenall classified dislocation motions as rapid or slow. Rapid movements were jerky and completed their action almost instantly, while slow motions involved gradual drifting of dislocations.

The movement of dislocations appeared to differ, depending whether they were associated with a single dislocation or a network of imperfections.

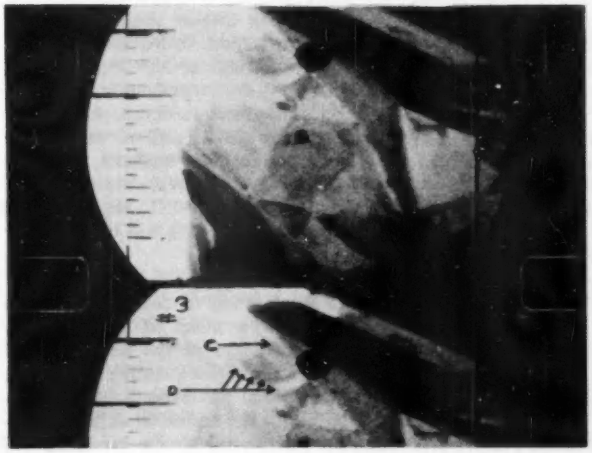



(*Above*) "A", a dislocation which moves to the right to engage the strain field of dislocation "B".

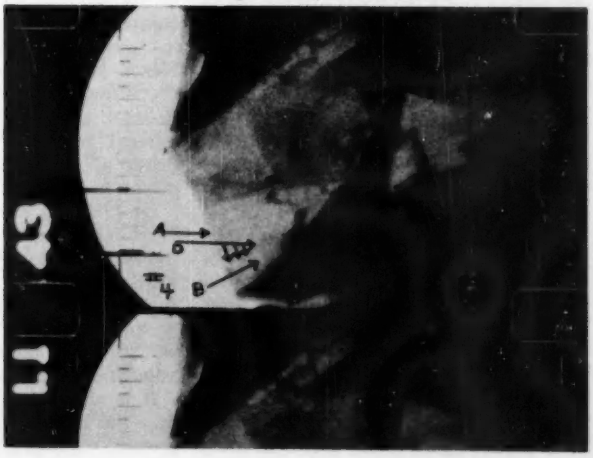



(*Above*) An intermediate stage of the interaction of dislocation strain fields "A" and "B". The stress generator is "C".

(*Below*) The strain fields of dislocations "A" and "B" have merged to activate the stress generator at "C" and produce a series of dislocation loops "D".




(*Below*) The dislocations have all moved out of the crystal to leave the material more transparent to electrons than before. Note the absence of dislocations "A" and "B" and those previously indicated at "D".



# BRITISH ASSOCIATION MEETING

## THE B.A. RETURNS TO YORK

As the first meeting of the British Association took place in York in 1831, it was natural for the 2800 visitors to the city to think, though perhaps only briefly, of the past. The days are now long past when the existence of the Association was criticised, as Charles Dickens did in 1837 in his famous "Mudfog Papers". His often quoted passage included such subjects as Umbugology and Ditchwateristics. In York this year the subjects of the papers ranged from nuclear science to cell culture, and from the economics of transport to problems of the moon.

Since the original function of the British Association, to communicate the first results of a new line of research, has now ceased, it is not out of place to recall some of the outstanding announcements that were made at previous meetings. To mention only a few: in 1866, Huggins reported on his combination of the spectroscope with the astronomical telescope; Joule gave the results of his researches on the mechanical equivalent of heat, in a paper delivered to the British Association at Cambridge in 1845; and at the Sheffield meeting, in 1879, Crookes was able to demonstrate the existence of cathode rays.

Today the British Association is more concerned with communicating broad fields of science to the public and, as part of this new development, the Lister Kelvin, and Darwin Lectures are welcomed. These were inaugurated this year to give young research workers a chance to talk about their own work in a broad and general manner, and it is hoped that the high standards set this year will continue. The Lister Lecture, by Mr D. E. Broadbent, dealt with "Time to React"; Dr S. Brenner, the Kelvin Lecturer, gave a brilliant discourse entitled "Building Viruses", which he illustrated most ably with excellent models; Dr R. G. West, in his Darwin Lecture, talked about "The Effect of the Ice Age on British Vegetation".

Using visual media for the communication of science, Granada television broadcast four programmes that helped to bring the deliberations of the scientists at the BA to the general public. BBC sound and television also covered the meeting extensively.

As in previous years, scientific films were shown throughout the meeting and there were two world premières at York: the Shellmex and BP film, *Land Reclamation*, and ICI's *Distillation*. The usual Saturday morning meeting on the use of film in research was devoted to the subject of transport research: some outstandingly good examples of this technique were shown by members of the British Transport Film Unit. Particularly noticeable was the use of Vernier scales for accurate measurement of small displacements, such as a truck hitting a stationary buffer.

A local exhibition showed how science is taught at York schools. Pupils are encouraged to perfect their own equipment and take part in field observation relevant to their work. One example showed a series of remarkable bird drawings. In this context the Junior British Association must also be welcomed. Its first meeting, at Nottingham, took place in July and was attended by 3000 young people.

Since 1958 the British Association has received grants worth £167,000 from industry. However, if it expects further financial aid in the future and if it continues to make the communication of science its major aim, the Association must continue to give serious consideration to its new role. It should use the scientific method of observation and experiment far more fully to get the best use from the new media of mass communication.

The excellent organisation of the meeting by the local secretaries and the permanent staff of the British Association, under Sir George Allen, together with the hospitality of the City of York, made this meeting in the foundation city very pleasant.

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### Man and the World's Fauna

In his Presidential Address to the Zoology Section, Dr L. Harrison Matthews considered how Man's activities have affected the world's fauna, how some of the population problems of the fauna have been studied by zoologists, and how conclusions may be drawn from them.

Man has always expanded his environment and thus preyed on the fauna of the world. Until historic times this did not matter, as human population was comparatively small. However, for the past five or six thousand years man has increased. Dr Harrison Matthews then traced Man's near-extermination of various animals, for example the Arctic whale, seals, and the American bison. Today Man is still not doing enough for the fauna of the world, though he has made attempts to conserve and control it. This latter state is most important. When animals become overcrowded they suffer acute psychological stress, known as stress syndrome. The whole population suffers from an acute psychological tension which acts, though it is not yet known how, upon the pituitary. This appears to result in over-production of the adreno-cortical stimulating hormone (ACTH), and this, in turn, over-stimulates the adrenal. Hence the production of adrenalin is first stimulated and then completely exhausted, and it is the breakdown of the adrenal function that causes the rapid death of the animals and the sudden, dramatic decrease of the population.

Dr Harrison Matthews then moved on from fauna to Man, and, by comparing the stress syndromes of the two, put forward a fascinating argument: "Can it be that the pace of modern civilisation is producing a mass stress syndrome that will bring a catastrophic crash of the populations of America and Europe?"

It is already well known that if Man does not take steps to control population growth, something disastrous will happen. Dr Harrison Matthews has put forward an interesting and terrifying theory. He considered the following three choices: to do nothing and wait for the stress syndrome to act, which might take the form of a new virus disease similar to myxomatosis; the second, to leave the destruction of civilisation to the trigger-happy politician with the largest stock of nuclear weapons; the third, to decide what is the optimum population and to ensure, by completely innocuous methods, that it is not exceeded. "History, unfortunately, gives no encouragement to the hope that the desirable alternative will be chosen."

### Cell Culture

Within the last ten to twelve years there have been a number of revolutionary technical advances in the knowledge of tissue culture. Consequently, knowledge of virus disease has extended and information about the action of different substances on the metabolic behaviour of

cells is accumulating. A start has also been made with the study of the genetics of human somatic cells.

Dr J. Paul of Glasgow University explained how these advances have led to the development of a new branch of tissue culture which is known as cell culture. The essential feature of cell culture is that the tissues are completely broken down into individual cells which can then be made to grow much like bacteria or amoebae.

These advances started when it was found that many animal cells could be made to grow and multiply indefinitely in suitable culture conditions. This led to the discovery that tissues could be disrupted by treatment with the digestive enzyme, trypsin, and that the cells released were not killed but could go on growing. Many of the cells obtained in this way were shown to be capable of growing on the bottom of glass vessels in relatively simple liquid media. They could be suspended again by treatment with trypsin so as to permit transfer to other culture vessels. By extension of these techniques it proved possible to grow cultures from single animal cells so that pure strains could be obtained. The most recent advance has been to grow animal cells as suspensions in liquid media by adopting measures, such as stirring, which prevent the cells from settling down. This permits animal cells to be manipulated with the same ease and precision as micro-organisms, such as yeasts and bacteria.

**Perception, Attention, and Consciousness**

It appears that there are many degrees or levels in the clarity and detail with which we are aware of our surroundings, varying from a precise and accurate perception of that part of the environment upon which attention is concentrated and focused, to a very vague marginal awareness of its less important aspects, and even to a type of perception of which we are not directly aware, but which nevertheless affects our actions in some way.

Prof. Magdalen D. Vernon of Reading University gave descriptions of some of the numerous experiments made to try to discover how much human beings can perceive and how perception and attention can be increased according to the interest or monotony of the experiment.

There are circumstances in which people spontaneously perceive certain aspects of the field of view particularly readily. If they have strong feelings about what is shown to them or if they desire to perceive or to avoid perceiving something, then not only is the speed of perception altered: they may even think they perceive what is not actually there, or, alternatively, they may fail to do so when it is there.

Evidence has been obtained in recent years to show that events of which observers are not consciously aware may yet influence their thoughts and actions. One experiment appeared to show that before the observer became sufficiently aware of, for example taboo words, he gave a psychogalvanic reflex response to them to be able to report them. This is a reflex decrease in the resistance of the skin to an electric current, which occurs as part of the response of the autonomic nervous system to painful and emotional stimuli.

In recent years the psychological evidence for the variations in conscious awareness which occur in various types of perceptual situation and with varying degrees of attention has been related to certain physiological processes occurring in the central nervous system—especially to the functions of a particular type of nerve tissue in the subcortical region of the brain known as the recticular formation. The activities of this appear to be associated with the arousal of awareness, the maintenance of vigilance, and the direction of attention to specific events.

**Dental Decay**

A whole session was devoted to the problems of dental decay and fluoridation. According to Dr J. L. Hardwick of Birmingham University and Dr R. L. Hartles of the University of Liverpool, the nation's teeth are in a worse state than ever, despite school dentistry. The deterioration increased at the beginning of the 19th century, when dietary habits changed considerably. Evidence from Anglo-Saxon skulls shows very little dental decay.

Both speakers recommended a slice of apple after every meal. They suggested that school meal service might make this a regular habit—the cost would be negligible. Also, they both felt that fluoride in drinking-water would probably decrease decay by about half.

**"Economics of Transport"**

Sir Reginald Wilson, a member of the British Transport Commission, said an efficient and economical system of transport is rather like Salvation. Everybody wants it without paying for it. Of the 209,000 miles of right-of-way in this small and crowded island, the railroad track accounts for only one-tenth, though being highly mechanised and disciplined it carries almost half the freight and a fifth of the passenger traffics; the nine-tenths of track, which is ordinary road, carries the *private* transport, however, and the great demand for private transport is a feature of our age.

Society is entitled to choose, but should not deceive itself about the consequences on (*a*) the public services, both road and rail; and (*b*) track and track cost. To guide our understanding, a new calculus or "social accounting" is called for. The true economics of carrying are very different from what appears on the surface or in the accounts of the carriers themselves—train, bus, lorry, and car. Arbitrary taxation, differing burdens of track cost, licensing and public-service obligations, controlled charges and imponderables like safety, all assist to obscure the position. To take only one example, how much should railways pay for their track, coping as they do with fog, snow, and the peak traffics of society? If, like their road competitors, they paid fuel duty instead of the burdens actually falling upon them, they would be £70 million a year in the black instead of the red!

It seems certain, Sir Reginald continued, that if we could forget the more extreme doctrines on both sides, and arrange for some intelligent combination (not integration) between carriers on the basis of their true economics, we would save tens of millions of pounds every month, cheapen transport considerably, and reduce congestion on the roads. We would also prepare the way for great technical developments which are possible in favourable circumstances.

Apart from this, to do without a sound public understanding of the road-rail question will prove horribly expensive in capital demands and in frustration. We need careful studies along new lines which will take account of the indivisibility of the problems of right-of-way, road and rail, and aim at impartial and up-to-date appraisals of the facts and possibilities. In other words, it is a question of science to the rescue.

**Intelligence and Racial Differences**

Negroes, and other, more primitive peoples generally score lower than British or American whites on intelligence tests, whether of a verbal or non-verbal or practical type. Most contemporary psychologists and anthropologists attribute this more to poor economic and educational opportunity than to innate differences between races; and they point out that intelligence—however assessed—depends not only on the genes but on the kind and amount of intellectual stimulation received from the environment, on familiarity with the type of test used, and on motivation or attitude towards doing intellectual tasks.

However, Prof. P. E. Vernon of the University of London stated that very extensive studies of the American negro suggest that the whole of the negro-white difference is not made up when environment and education are improved. Thus it is possible, though by no means directly

proven, that negroes—while differing little from whites in perceptual and muscular skills, in rote memorisation and some other abilities—may perhaps tend to lack some of the genes underlying advanced reasoning powers. Similarly, there may be real differences between aboriginal Australians and other racial groups, though the evidence is even less conclusive. At the same time, there is so much overlapping between groups (that is, so wide a range of ability within every racial group) that this conclusion would provide no justification for segregating any one racial group as universally inferior to another. Again, the failure of tests to measure truly innate differences does not mean that they cannot be extremely useful for purposes of educational and vocational guidance within African, Indian, or other non-white societies.

**Marine Aquaria in the Laboratory**

Laboratory aquaria must be capable of supporting a wide variety of organisms in a healthy condition over long periods. These organisms are required as experimental material for research in a number of fields; students need them for study; and a successful aquarium is a useful tool for the marine ecologist.

To meet this requirement the marine environment must be maintained in the aquarium. Probably the most important difficulty in doing this is that animals excrete ammonia, or substances quickly converted to ammonia; putrefaction of dead animals and plants also produces ammonia. Ammonia is poisonous and would soon inhibit life in an aquarium.

However, sea-water contains bacteria which change ammonia to nitrite, and then to nitrate. These bacteria are found especially on solid surfaces such as sand, mud, and suspended particles; they probably carry out these changes best on a chalky substratum such as mollusc shells. Curiously, they also require iron, and this is present in diatoms and in suspended particles.

Nitrates are not poisonous; indeed they are necessary as food for marine plants as they are for land plants. Animals feed on plants, or on other animals which in their turn have fed on plants. So the cycle is completed.

An aquarium has been built by Dr L. J. Hale at the Zoology Laboratory of Edinburgh University possessing these conditions which support this cycle of events. The water is energetically circulated in the tanks to transport ammonia from animals to bacteria, and nitrates from bacteria to the plants; it maintains particles in suspension; and there may be other reasons for reproducing the active water movements present in the sea (tides, currents, and waves). The aquarium has run for over two years using the same unfiltered water, and has successfully supported a variety of marine organisms.

**Radiocarbon Dating**

The possibility of age determination by the radiocarbon method derives from the fact that the carbon atoms of living material include a minute concentration of a radioactive isotope of carbon, carbon-14, in equilibrium with its environment. When death occurs, this equilibrium is no longer maintained and the carbon-14 atoms decay at a rate such that the concentration is reduced to one-half its initial value in about 5600 years. A measurement of the residual activity in dead material provides an indication of the time elapsed since its death.

Mr W. J. Callow of the National Physical Laboratory explained that the measurement of this residual activity was simple in conception, but it had technical difficulties due to the very small natural radioactivity of the carbon-14 in living material, the concentration is only about one in a million million, corresponding to about fifteen disintegrations per minute per gramme of carbon. The measurement is made possible by the detection and counting of the $\beta$-particle emitted when a carbon-14 nucleus disintegrates, the maximum energy of this $\beta$-particle is low and thus gas counting is usually used. The material is first converted to carbon dioxide, which is then highly purified and used as the filling gas for a proportional counter. This is essential to achieve maximum detection efficiency for the $\beta$-particle and to avoid possible contamination with radioactive fall-out.

Such a proportional counter is sensitive not only to $\beta$-particles from the sample but also to "background" radiation. The count rate arising from this background in a normal room is many times that from even recent material and has to be greatly reduced by elaborate shielding. Six to twelve inches of steel are used to absorb local $\gamma$-radiation, and in addition Geiger counters are arranged to reject counts due to cosmic-ray mesons.

The counting rates involved are about a few counts per minute for background and range from a few tens of counts per minute for modern material to less than one count per minute for ancient material. To achieve a sufficient precision in the statistics of a measurement counting times as long as 24 to 48 hours may be involved, thus the electronic circuits used must be very reliable and preferably be arranged for automatic recording.

At the National Physical Laboratory great emphasis has been placed in the design of the equipment to ensure as far as possible easy and trouble-free operation.

**Time to React**

Experimental work is being done to try to establish exactly how Man makes a decision. It has been known for some time that there is a marked delay between the time a signal strikes the ear or eye, travels to and from the brain along the nerves, and the appearance of the appropriate action. This delay takes place in the brain where a decision is being made.

Mr D. E. Broadbent, of the NRC Unit at Cambridge, described some of the work being done. It is known that auditory reactions are faster than visual ones, because the nervous messages get to the brain more quickly. So the auditory signal ought to block the decision mechanism for less time than a visual signal does, and therefore interfere less with a second signal coming just after it.

It has been suggested that the brain does not take in a continuous chain of events, but a fairly lengthy sample of what is going on in the world, and that this whole sample passes through the decision-process in one chunk. If the second of the two signals misses the end of the sample which contains the first signal, it will have to wait until the next sample goes to the decision mechanism. To substantiate this latter theory, it has been proved that people have difficulty in detecting the order in which sounds occur —though they know the number of sounds that have occurred.

The position now reached is that (1) the single-channel view (continuous chain of events) of decision does not altogether explain why the second of two signals gets a slow response; (2) an alternative view, that the brain takes in sensory information in successive chunks rather than continuously might explain this; (3) people are bad at detecting the time order of events, as they well may be if this second view is true.

**Bacterial Cell Walls**

To understand how food and waste products are transported in and out of cells it is essential to understand the physical and chemical structure of the cell wall. The importance of this work has increased considerably since it has been shown that penicillin and some other anti-bacterial substances act on bacteria by interfering with the formation of their walls.

Prof. J. Baddiley is doing research on this subject at Durham University. The cell walls are separated from bacteria by violent shaking in the presence of minute glass beads, followed by filtration and centrifugation. Preparations obtained are then hydrolysed to their component parts, which are identified. Although the structure of the wall has great chemical complexity, the number of components required in its formation is not large:

most walls contain about four different amino-acids and about three different sugars.

The amino sugar, muramic acid, occurs exclusively in bacterial walls or their precursors. This is probably joined to another amino sugar, glucosamine, and to peptide residues in the wall. In the presence of penicillin, wall synthesis is inhibited and precursors accumulate in the cell. Some of these precursors are nucleotides containing muramic acid—peptide groups which are believed to be transferred normally from the nucleotide into the wall structure when penicillin is not present.

Other nucleotides which occur in bacteria contain phosphoric esters of glycerol or ribitol, and it has now been shown that polymers of these phosphates occur in many bacterial walls. These polymers are called teichoic acids, and their composition varies in different organisms. Recent work has almost completely determined the chemical structure of one of the group: the ribitol residues are joined together through phosphate groups, and each residue bears one glucose and one alanine substituent. Polymers of this general type have not been found before in nature.

**Electrons in Crystals**

Solid matter exists in a variety of external forms and with a wide range of physical properties: hard, soft, metallic, transparent. The fundamental interest of physicists is to explain this in terms of the atomic constitution of the solid. Most solids have a crystalline nature, although their outward form may not reveal it. On an atomic scale their atoms form orderly three-dimensional arrays in space which can be revealed, for example, by the techniques of x-ray diffraction.

Prof. G. F. J. Garlick spoke about the optical and electronic properties of crystalline solids which depend on the behaviour of electrons inside the crystals. To explain why some solids are metal and opaque, some transparent, translucent or coloured and often electrically insulating, and why there is a wide range of materials with intermediate properties known as semiconductors, it is necessary to use the ideas of wave mechanics. This means that the electron can no longer be thought of as a tiny particle of matter like a billiard-ball with a negative electric charge, but account must be taken of its wave-like properties which were first revealed in electron diffraction by crystals in 1927. The faster an electron moves the shorter is its wavelength. In free space the wave nature of an electron still allows normal behaviour as a charged particle, but in the regularly repeating lattice of a crystal unusual things happen. Electrons can be heavier or lighter when they are in free space (neglecting high-velocity behaviour). They belong to the whole crystal and cannot be found at localised places unless the crystal is imperfect or impure. When electrons leave given energy states the spaces left behind can move as positively charged electrons or positive holes.

The fundamental study of electrons in practical crystals, which are never perfect, has led to a silent but powerful electronic revolution: transistors or crystal triodes compete with vacuum radio valves, crystal photoelectric solar generators provide power for artificial satellites, the thermoelectric refrigerator might be a possible rival to the present one, and electronic computers become faster and smaller as solid-state crystal devices replace present valves and memory devices.

**Man and the 24-hour Clock**

Between 1953 and 1955, Dr Marv Lobban of Cambridge University carried out some experiments on people who normally lived in temperate climates (where night is always associated with darkness and day with light) and then took these people to Spitsbergen with its 24-hour daylight. This proved that man's physiological activities are geared to a well-marked 24-hour rhythm. The clock which governs this periodicity is often quite difficult to set to a new rhythm and it may not be possible to set it at all. Dr Lobban found that different physiological rhythms could be separated and adapted to different degrees and at different rates. This suggests that there may well be more than one internal clock.

More recently, Dr Lobban has been working on indigenous Arctic peoples (Indians and Eskimos) in Alaska and in Arctic Canada. From this work it seems that environmental factors may influence physiological diurnal rhythms more than had been thought. Such factors as temperature and exercise, especially severe physical exertion, may well exert profound effect in deciding whether or not any one individual will adapt successfully to a new routine.

**Chance and Probability**

Luck still plays a large part in the lives of many people: lucky charms, days, colours, numbers, and lucky people. Prof. John Cohen of Manchester University thought that the experimental study of luck might constitute an important factor in the formation of our aspirations, decisions, and actions. What we believe will actually happen seems to depend on what we think will happen if we are lucky or unlucky. Similarly, what we expect to achieve at any particular task depends on what we think we should achieve if we were lucky or unlucky.

Dr J. Beloff and Mr K. Warwick of Belfast informed their audience that the concept of "wishful thinking"—perceptual autism—is now a commonplace. When gambling, an autistic individual would "see" the lucky symbol more often than would otherwise be the case; this applies only if he is allowed to back his fancy—the autistic tendency disappears in a lottery system.

**The Use and Misuse of Science**

Some of the highlights of the Presidential Address in 1969, ten years from now, were forecast by Ritchie Calder in his address to Section "X":

The "break-through" in fusion energy, with the implications for the trade in fission reactors and the competitive industrial emergence of "under-developed" countries.

The new species, man-created by DNA (desoxyribonucleic acid), with a warning of the dangers of the misuse, by motive or by ignorance.

An electronic memory, which by cryogenics (Freezing to Absolute Zero) makes possible the "memorising" in a capacity no greater than that of a cigar-box, of all the knowledge in all the libraries in all the world, and of all the police dossiers.

The lessons, and warnings, from the first landings on the moon and the effects of competitive space-travel.

The world population of 1969 has passed the 3000 million mark and the advanced countries of the northern temperate zone are alarmed by their diminishing proportions, by their competitive dependence on food and by the technological insurgence of countries regarded as "backward".

A review of the advances in medicine and of the diseases which have disappeared.

The paper reviewed, retrospectively, the historic cases of the use and misuse of science, with the reminder that the scientist can no longer disown responsibility. In the past the scientist was the innocent "accessory before the fact" who could always plead that others had taken his discoveries and perverted them. On the same page of a chemical dictionary one could find juxtaposed chloroform and mustard gas, but the chemist who noted the chemical properties of mustard gas did not foresee its use as a weapon of war. The scientists who proposed, and proved, the release of atomic energy, themselves conceived it as the nuclear bomb. Scientists, aware of the implications of their researches, have a duty to the public to share that awareness.

Ritchie Calder concluded this imaginative address with: "Scientists leave their discoveries like foundlings on the doorstep of society. The step-parents do not know how to bring them up."

# SELENOGRAPHY: MAPPING THE MOON

**PATRICK MOORE, F.R.A.S., F.R.S.A.**

*Director of the Mercury and Venus Section of the British Astronomical Association (Secretary of the Lunar Section, 1945–55).*

*Although man has now made the first physical contact with the Moon's surface and much has been learnt about the landscape of the Moon through distant observations, our knowledge is still limited. Space research with its promise of manned rockets offers manifold opportunities for checking current theories and for filling in the picture.*

The Moon is the only celestial body which is close enough for its surface features to be examined in great detail. Since it is less than a quarter of a million miles away, our telescopes will show minute features upon it, and we might expect lunar charts to be as precise as those of our own world. Actually this is not so, but a survey of past work will help to give a balanced idea of how the problem has been attacked.

Even in Classical times the existence of bright and dark areas upon the Moon had been noted, and Anaxagoras of Clazomenæ, who lived from 500 to 428 B.C., stated that it contained "plains, mountains, and ravines". Little could be done with the naked eye alone, however, and the first man to obtain a reasonably clear view of the surface detail was Galileo, who observed it with his first crude astronomical telescope in the winter of 1609–10. The mountains, craters, and ridges so familiar to us came as a surprise to Galileo, but in one respect at least he seems to have been in advance of his time, since he realised that the dark plains known as "seas" do not in fact contain water. Galileo's chart of the Moon, rough and inaccurate though it was, may be said to mark the beginning of true selenography.

## NAMING THE CRATERS

While Galileo was carrying out this work in Italy, news of the invention of the telescope spread, and in the following years several instruments reached Britain. From Traventy, in Pembrokeshire, Sir William Lower used one of them to view the Moon. He described the broad plains, craters, and other features just as Galileo had done, and said that at half-moon he could see the mountain-tops near the terminator "shining like stars", while the full moon resembled a "tart that his cook had made", with bright and dusky features scattered in confusion all over the disc. Not much is known about Lower, and he produced no work of real value, but he can claim a modest place in early selenographical history.

In those days the Moon was generally regarded as a habitable world, and most astronomers believed the dark plains to be true seas. For thirty years after Galileo's first observations, no better charts of the surface were produced, but then came the famous map drawn by Hevelius, a city councillor of Danzig, who built an observatory on the roof of his house and equipped it with the best instruments available. His chart, just under one foot in diameter, remained the best for over a century. Hevelius also measured the heights of some of the lunar mountains, and although his results were naturally rough they were much better than Galileo's. Several copies of the map are still in existence, but the original copperplate of it is no longer to be found; apparently it was made into a teapot after Hevelius' death.

Hevelius gave terrestrial names to lunar features; in his map, for instance, the crater now known as Copernicus was "Etna", while the modern Plato was "the Greater Black Lake". The system was clumsy and unsatisfactory, so that only half a dozen of his original names are still in use. In 1651, Riccioli, a Jesuit priest, produced a map which was not so accurate as that of Hevelius, but in which he named the various craters after eminent scientists and philosophers. Riccioli's nomenclature has stood the test of time, and has been augmented since, so that over 700 craters are now distinguished by separate names.

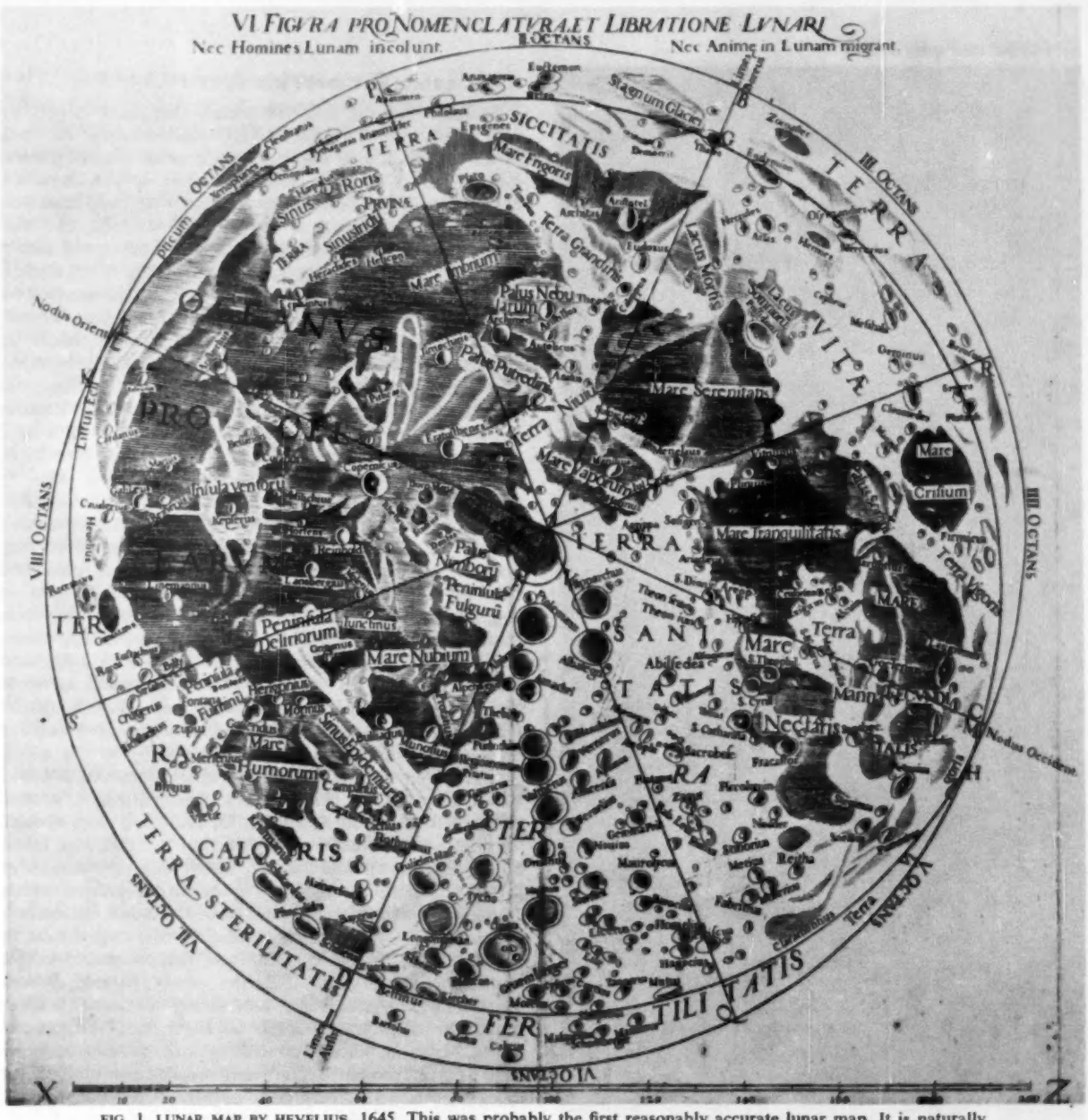
## THE "MIDDLE AGES"

For the next hundred years little progress in selenography was made, but in 1775 a German astronomer, Tobias Mayer, produced a comparatively accurate map about eight inches across. Mayer was followed by Johann Schröter, who started his lunar work about 1779, and may be regarded as the first really great observer of the Moon.

Schröter was not a professional astronomer. For many years he was chief magistrate at Lilienthal, near Bremen, and had ample means and leisure to carry on his hobby, though his work came to an unfortunate end towards the close of the Napoleonic Wars, when his observatory, together with all his unpublished observations, was burned by the invading French. He also carried out valuable work in connexion with the planets, particularly Venus.

Let it be said at once that Schröter is probably the most maligned man in astronomical history. Many modern textbooks state that his lunar drawings were inaccurate, his telescopes useless, and his theories wild. None of these charges can be substantiated. It is true that he was a clumsy draughtsman, but he seldom or never made a serious mistake, as careful examination of his drawings will show. His main reflector, a 19-in. by Schräder of Kiel, may well have been indifferent, but among his other telescopes were two made by William Herschel, the most skilful instrument-maker of the period. Admittedly, Schröter was wrong in suggesting that the Moon has a dense atmosphere and that striking changes occur on its surface, but in this he was not alone; his modern critics are slow to point out that even Herschel, one of the greatest observers of all time, believed both the Moon and the Sun to be inhabited.

Schröter never produced a complete map of the Moon, but he made many thousands of drawings and measurements. In particular, he obtained greatly improved values of the heights of lunar mountains. The basic method of such determinations is to measure the lengths of the shadows cast by the mountains across the adjacent surface;


VI FIGURA PRO NOMENCLATURA ET LIBRATIONE LUNARI
Nec Homines Lunam incolunt.
Nec Animæ in Lunam migrant.
II OCTANS
III OCTANS
I OCTANS
VIII OCTANS
IIII OCTANS
VII OCTANS
V OCTANS
VI OCTANS
TERRA SICCITATIS
Mare Imbrium
Mare Serenitatis
Mare Tranquillitatis
Mare Vaporum
Mare Nubium
Mare Humorum
Mare Crisium
Oceanus Procellarum
Sinus Roris
Sinus Medii
Sinus Aestuum
Palus Putredinis
Palus Nebularum
Palus Somnii
Palus Nostoni
Lacus Mortis
Lacus Somniorum
Insula Ventorum
Promontorium Agarum
Promontorium Archimedis
Promontorium Heraclides
Promontorium Laplacii
Promontorium Taurus
Promontorium Deliranum
Promontorium Fulguris
Promontorium Olivium
Promontorium Acherusia
Promontorium Agassiz
Promontorium Archerusia
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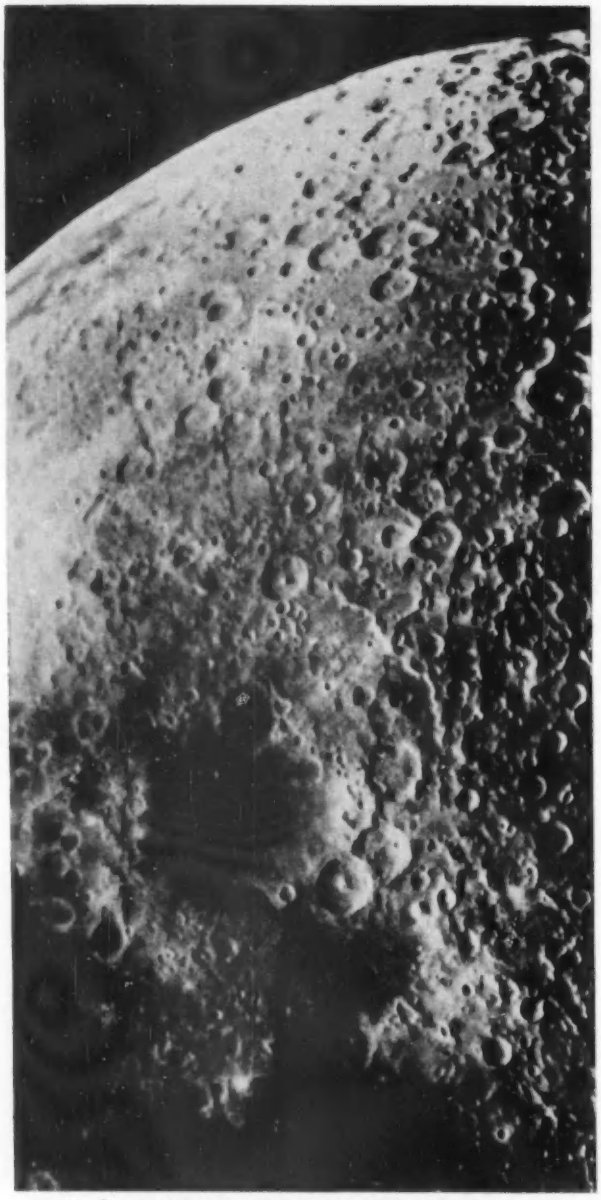


FIG. 2. PART OF THE SOUTH-WESTERN QUADRANT OF THE MOON. Photographed by T. W. Rackham with a 6-in. reflector. This shows one of the most crowded areas of the Moon, including the great chain of craters made up of Theophilus, Cyrillus, and Catharina. Theophilus may be seen about 2 in. from the bottom of the picture. It is 64 miles in diameter and 18,000 ft. deep. To the south of this chain of craters the Altai Mountains can be seen.

of interest in selenography. Beer and Mädler believed the Moon to be utterly dead and unchanging; their map was so good that it was regarded as the last word on the subject, and for the next quarter of a century very little lunar observation was undertaken, except by another German, Julius Schmidt, who carried out most of his work from Athens Observatory. Beer and Mädler themselves virtually abandoned selenography after Mädler left Berlin in 1840 to assume the directorship of Dorpat Observatory.

## THE LINNÉ CONTROVERSY

Schmidt revised and completed the chart begun by Lohrmann, and also produced an excellent one of his own. It was Schmidt, too, who caused a reawakening of general interest when, in 1866, he announced that the formation Linné, previously described as a small and deep crater on the grey plain known as the Mare Serenitatis, had disappeared—or at least changed its form and turned into a white spot. Even now the Linné controversy is not settled. At present the formation consists of a small pit situated on a swelling in the crust, and surrounded by a whitish nimbus; this is how I have observed it with the 33-in. refractor of the Meudon Observatory, and photographs have also been obtained. If this has always been its appearance, older workers such as Mädler—and Schmidt himself, before 1843—were mistaken in describing it as a deep, well-marked crater similar to the other prominent object on the Mare Serenitatis, Bessel.

Whether or not Linné did change in form between 1843 and 1866, Schmidt's announcement caused great discussion among astronomers, and once more lunar observing became the fashion. In 1876, Edmund Neison published the first detailed description of the Moon to appear in English, and accompanied it with a chart which was basically a revision of Beer and Mädler's. Neison, whose real name was Nevil, provides a link between the past and the near-present. He was only twenty-five when he wrote his classic book, and died as recently as 1938, though he seems to have taken no practical interest in the Moon for the last fifty years of his life.

Several other notable books and charts appeared at about this time, and the British Association formed a special committee to consider drawing an elaborate map, though very little was actually done. Mention must also be made of the Selenographical Society, which was very active for a few years around 1880, and published a journal which contained much valuable information, though the Society disintegrated with surprising rapidity following the death of its president (W. R. Birt) and the retirement of its secretary (Neison). In 1890 the newly formed British Astronomical Association established a Lunar Section under the directorship of T. G. Elger, and the various reports and memoirs produced by this Section between 1890 and the present day are well worth consulting. Elger himself published a very clear outline map, together with a description of each formation, in 1895.

So far we have been discussing charts drawn up by means of visual studies only. In modern astronomy, however, very little is done in such a way; for most purposes the photographic plate has replaced the human eye, and it is clear that a map based upon measured photographic positions as a framework will be of increased accuracy.

In 1840 the French astronomer Arago discussed the newly discovered daguerreotype process at a meeting of the Académie des Sciences. In the published report of this meeting, Arago is quoted as saying that "by this means we will be able to accomplish one of the hardest tasks in astronomy—mapping the Moon—in a few minutes". However, Arago grossly under-estimated the difficulties. It was twenty years before Lewis Rutherfurd in America began to produce really good lunar pictures, and a full photographic survey proved to be a major undertaking. (See page 437.)

## PHOTOGRAPHIC ATLASES

The first attempt at a photographic atlas appeared in 1897, and was the work of the French astronomers Loewy and Puiseux, working at Paris. These plates are extremely useful, and have been used to make accurate measures of the positions of standard features. Seven years later W. H. Pickering, in Jamaica, published another atlas; his aim was to photograph each part of the Moon under several different illuminations, and he actually did so, though it must be said that the results are not sharp enough to be really valuable for modern research.

Present-day charts naturally make use both of photographs, which are of unrivalled positional accuracy, and of visual work, which is capable of revealing detail so fine that the sensitive plate will not record it. The largest map so far published is that of the British selenographer H. P. Wilkins; the scale is 300 in. to the Moon's diameter, and there are special sections covering those parts of the Moon which lie close to the limb, so appearing very foreshortened and even being carried periodically out of view because of the changing "libration".

As most people know, the Moon revolves round the Earth in the same time that it takes to spin once on its axis, so that the same hemisphere is constantly presented to us. However, various effects known as librations allow us to examine 59% of the surface instead of exactly 50%. The Moon turns on its axis at a constant speed; but since its orbit is not circular, its velocity round the Earth alters, being greatest at perigee (nearest approach to the Earth) and least at apogee. In consequence, the axial spin and the position in orbit become regularly "out of step", and there is a slow, rocking movement known as libration in longitude; sometimes we can peer for some distance round the western limb, sometimes for some distance round the eastern. There is also a libration in latitude, due to the inclination of the Moon's orbit. These two effects, together with others of lesser importance, result in our being able to study more than one complete hemisphere of the Moon.

However, craters in these areas affected by libration are so foreshortened that to map them, either visually or photographically, is far from easy. Most of the old maps were drawn to mean libration, covering only 50% of the total surface, and in order to include the additional 9% Wilkins was forced to draw up separate charts. Even now our knowledge of the limb features remains far from complete, and much useful work may be done in this connexion by any observer who has the necessary equipment and patience.

Another virtue of photography is that it enables better estimates to be made of the depths of craters. In general, a crater has a depressed floor and a surrounding wall which does not rise to any great height above the outer country; by measuring the shadows cast by the walls, the inner and outer relief may be calculated in the same way as for mountain ranges. It is rather surprising to find that the average crater is much more like a shallow saucer than a deep-sided well. Theophilus, for instance, has a rampart rising to 18,000 ft. above the interior; but this is less than four miles, and is not much when compared with the diameter of Theophilus (64 miles).

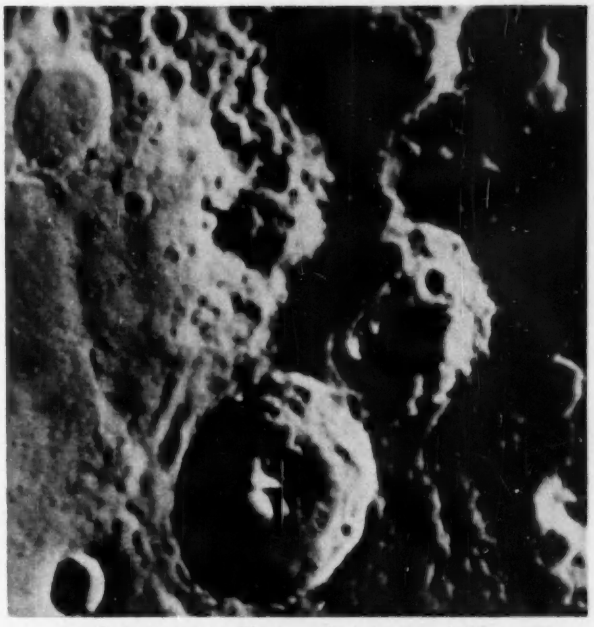


FIG. 3. THEOPHILUS. Photographed by Kopal, Ring, and Fielder, Pic du Midi; reproduced by permission of Dr J. Rösch. This shows an enlarged view of Theophilus, with its southern neighbour, Cyrillus. The smaller, deepish crater north-west of Theophilus is named Mädler, in honour of the great selenographer Johann Mädler.

FIG. 4. A LUNAR CLEFT. This shows the Ariadaeus Cleft, one of the most interesting of the lunar clefts or rills. Photographed by Kopal, Ring, and Fielder, Pic du Midi; reproduced by permission of Dr J. Rösch. The cleft itself may be clearly seen; the large, low-walled dark-floored formation below (north of) it is Julius Caesar.

## SELENOGRAPHY BECOMES PROFESSIONAL

Until the last few years, mapping the Moon was regarded as being largely the province of amateurs. It is true that the International Astronomical Union did produce an official chart in the 1930s, but this is so crudely drawn and inaccurate that it is not a great deal of use, and no steps were taken to revise it until after the end of the last war. Nowadays the whole position has changed. Space research means that the Moon is coming within our reach, and there is a new and urgent need to explore its surface as minutely as possible. Professional workers as well as amateurs have accepted the challenge, and at the moment photographic programmes are being carried out both in America, under the direction of G. P. Kuiper, and at the high-altitude Pic du Midi Observatory in France, where some of the best of all lunar photographs have been produced. It is to be hoped that these programmes will prove fruitful, and that publication of their initial results will not be long delayed.

Photography must form the basis of all current work, for reasons which are obvious. What is not so generally realised, however, is that direct visual observation is also valuable; on the Moon, at least, the eye is in some respects superior to the sensitive plate, and while carrying out studies with very large telescopes (notably the Meudon 33-in.) I have had personal proof of this. Moreover, photographs can be misinterpreted; it is essential for the modern selenographer to have direct acquaintance with the lunar surface—and this is sometimes forgotten. Recently, for instance, photographs taken in America revealed some twenty objects which took the form of rounded hills crowned by craterlets, and which looked remarkably like old volcanoes; this was announced as a new discovery, even though visual observers had long since been familiar with over fifty similar objects. In astronomy it is only wise to make use of all methods of research and not to concentrate upon one to the exclusion of all others.

Detailed charts of the Moon are necessary because of the development of space research, but there are many by-products of such studies. To take just one example: How were the lunar craters formed? At the moment there are two schools of thought, and no general agreement has been reached. Some authorities regard the craters as basically igneous, while others prefer the theory that they were produced by meteoric bombardment. Careful study of the characteristics and distribution of the craters is the only way to reach a decision, and this cannot be done without precise mapping.

There is also the problem of whether any minor variations occur on the surface. Linné is the classic case, but it is by no means the only one. No definite instance of change has yet been proved, but the whole question remains completely open, and was brought into renewed prominence in November 1958, when the Russian astronomer N. Kozirev, working with the 50-in. reflector at the Crimean Astrophysical Observatory, reported a disturbance inside the large crater known as Alphonsus. Kozirev obtained confirmatory spectrograms, and there seems no doubt that some kind of outbreak did occur, but its visible traces are less certain. A reddish patch near the site of the disturbance has been widely reported; personally I have failed to detect it, but it is clear that the whole area merits close and continuous watch. Here again, accurate charts are a necessity.

We have seen that 41% of the lunar surface is permanently hidden from our gaze, since it is always turned away from the Earth. Naturally, its topography remains unknown—and yet a little progress has already been made in mapping it, since use has been made of the remarkable features known as lunar rays.

Some craters, notably Tycho and Copernicus, are the centres of ray systems. The rays appear as bright streaks, best seen under conditions of high illumination, and may extend for hundreds of miles; near full moon the Tycho and Copernicus systems dominate the lunar scene. Their precise nature is something of a mystery, but they are certainly surface deposits, and volcanic ash is a possible answer. In any case, minor ray systems are very common, each centred upon one particular crater.

## THE INVISIBLE CRATERS

About eighty years ago N. S. Shaler, an American geologist who paid considerable attention to the Moon, detected faint rays coming over the limb from the averted position, and diverging steadily. Presumably they came from craters on the hidden side, and careful plotting and calculation might in this case be expected to betray the positions of the invisible craters. Shaler made six such estimates, and modern studies by E. F. Emley, Wilkins, and others have increased this list to more than a dozen. The charted positions are certainly of low accuracy, because the limb-rays are very faint and difficult to observe, but at least we have made a start in studying the hidden part of the Moon. Here again there is scope for the skilful owner of a modern telescope, since the features are too elusive to be photographed.

Fortunately, it should not be long now before we have some really definite information about the hidden side of the Moon—and this brings us to space research as applied to selenography.

In 1958 American scientists launched a rocket, the *Pioneer*, which was designed to go on a "round trip". The intention was to send it round the Moon, so that it would pass over the hidden side; it was equipped with cameras, and it was hoped that the photographs could be sent back to Earth by means of television techniques. The difficulties of such an operation were immense, and in fact the project failed owing to an error in the rocket's orbit; having reached an altitude of 79,000 miles, it fell back to Earth and was destroyed in the high atmosphere. Yet it was a beginning, and it will be surprising if success does not come within the next decade. If we are to study the averted portion of the Moon, we must do so by means of rocket vehicles; there is no other way.

Since then, great strides have been made by Russian workers. The first Soviet lunar probe—known officially as "Mechta", but more generally as *Lunik I*—passed well within 5000 miles of the Moon; it was not designed to return to Earth, but continued on its way, and became a satellite of the Sun. Presumably it will continue moving round the Sun indefinitely, so that it has become a tiny artificial planet.

In September 1959 the Russians carried out an even more spectacular experiment: they landed a vehicle on the lunar surface. *Lunik II* continued to send out radio information until it actually hit the Moon, and it is to be hoped that

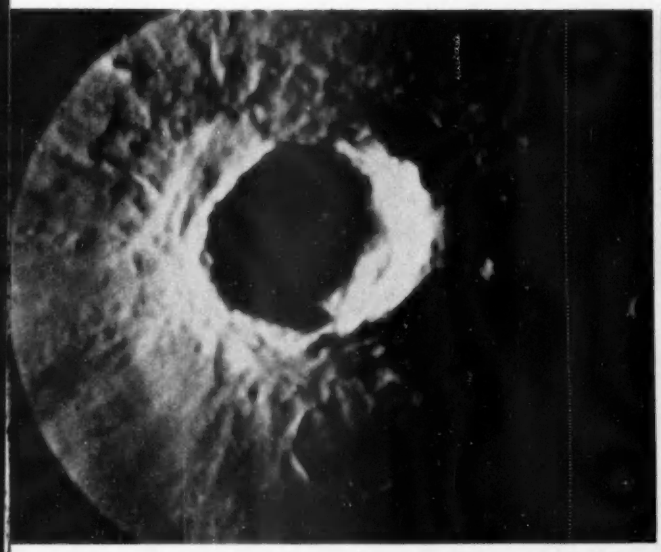


FIG. 5 (*above*). ARISTILLUS. An example of a well-formed lunar crater; note the "ghost" ring adjoining it. This photograph was taken at the Pic du Midi Observatory.

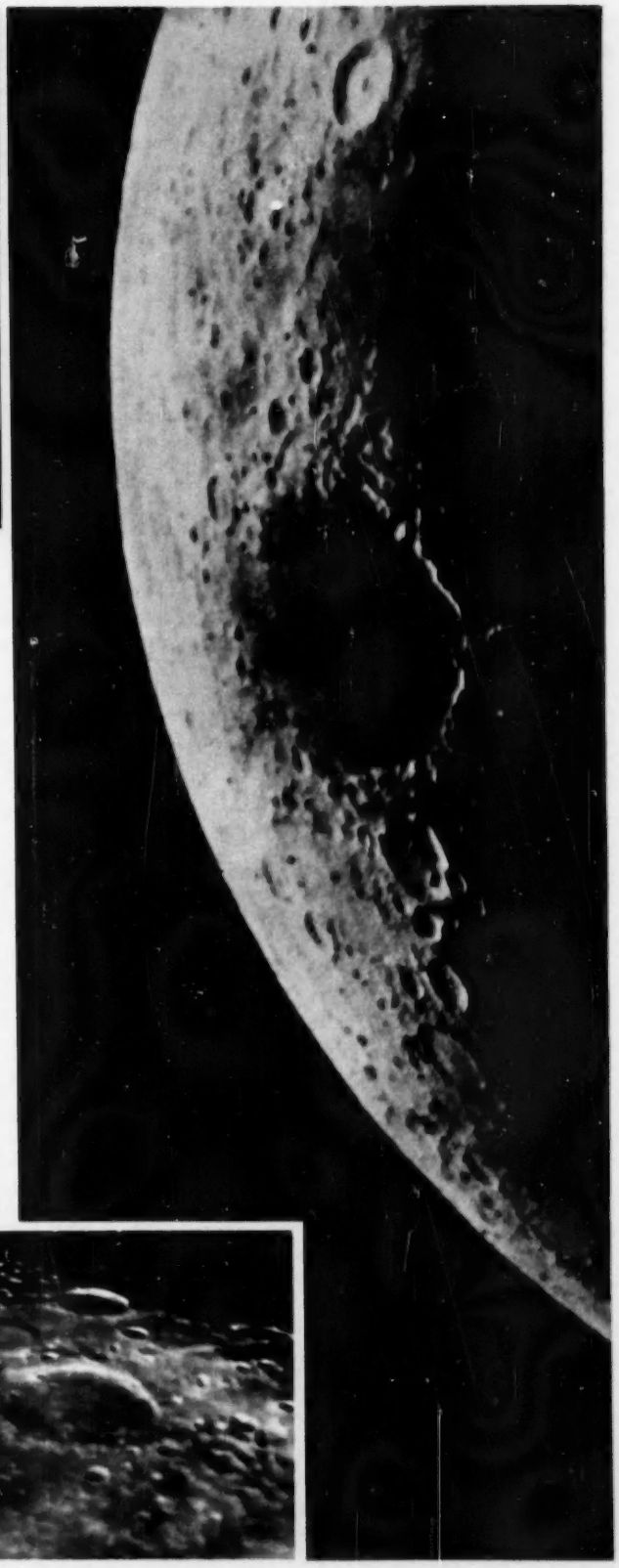


FIG. 6 (*right*). PART OF THE CRESCENT MOON, which was photographed by T. W. Rackham with a 6-in. reflector. The large dark-floored plain is the Mare Crisium; the small craters on it are Picard and Peirce. Above (south of) it, near the top of the picture, is the great crater Langrenus. The large formation near the north of Mare Crisium is named Cleomedes.

FIG. 7 (*below*). THE SOUTH-EAST LIMB OF THE MOON, photographed by E. A. Whitaker. The large formation on the limb, towards the left-hand side of the photograph, is Bailly, which has a diameter of nearly 180 miles, and the biggest formation classed as a crater. It has been aptly described as "a field of ruins". To the right-hand side is the very large crater Schickard, and close to Schickard is Wargentin, a crater 54 miles in diameter, which has been filled to the brim—so that it now resembles a plateau. The very prominent deep crater above Schickard is named Inghirami.

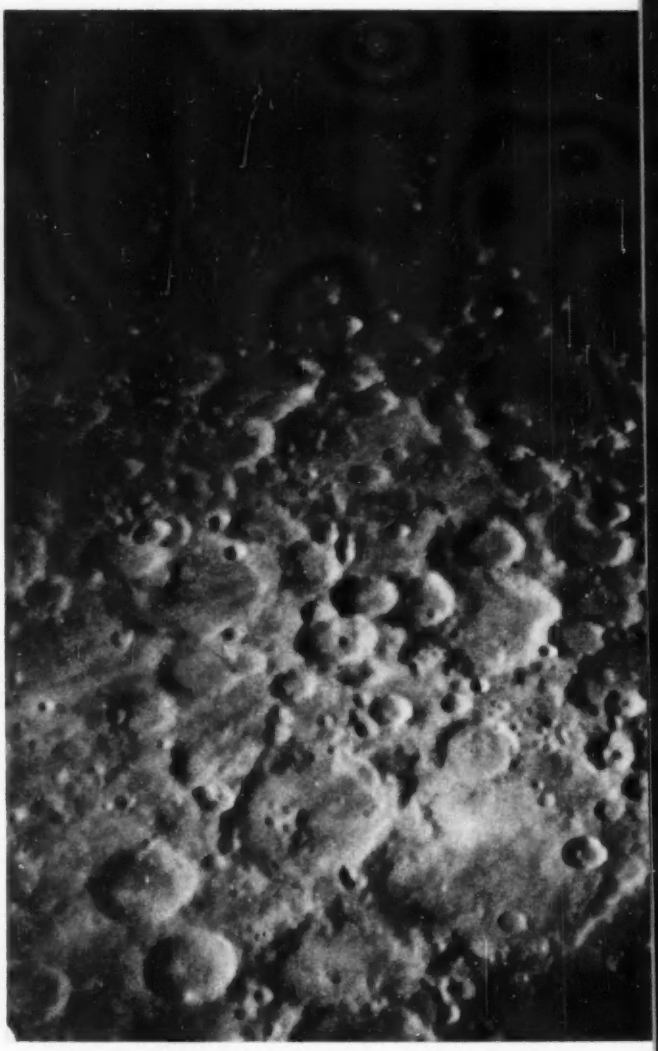
much new knowledge has been gained, though full results are not yet available.

The next step will be to land a rocket sufficiently gently to avoid destroying its instruments, so that it will come down on the Moon and act as an information transmitter. It must be remembered that there is still much that we do not know; for instance, how deep is the surface layer? It is generally thought that the Moon is partially or wholly covered with a layer of ash and dust from 1 to 6 in. deep, but experiments with rocket vehicles provide the only means of finding out for certain.

## SURVEYORS ON THE MOON

Eventually, there is every hope that manned vehicles will reach the Moon. This still lies some way in the future, but it is now generally recognised that space-travel is a real possibility instead of the pipe-dream of a few fanatics. When this happens, selenography will pass from the realm of the astronomer to that of the surveyor. The basic problems will be the same as on Earth, but there will be differences in detail; there is no convenient sea-level to act as a standard for heights, so that the "mean body" of the Moon will have to be used instead, and the greater curvature of the surface will demand the use of smaller survey-triangles than is practicable here. These are, however, minor problems, and it is clear that maps of the Moon will attain extreme accuracy—once we can get there.

Selenography has a long history. It began in Classical times with the Greek philosophers who gazed at the bright and dark areas on the Moon and wondered at their nature; it continued with the work of telescopic pioneers such as Galileo, Hevelius, and Riccioli; it was raised to a true science by Schröter, Beer, and Mädler. We have reached the photographic era, and we are on the brink of the rocket era, when close-range pictures will be taken of both the earthward and averted areas. Yet our knowledge will not be complete until men can actually stand on the surface and carry out practical surveys. Then, and only then, will we be able to solve the Moon's most puzzling secrets.



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—— and Moore, Patrick, "The Moon", London, 1955. A reduced-scale reproduction of Wilkins's map, with a description of each formation.

FIG. 8 (*above*). THE TYCHO AREA, photographed by G. A. Hole with a 24-in. reflector. It shows Tycho, which is the centre of the greatest ray system on the Moon. Tycho is 54 miles in diameter, and may be seen not far from the centre of the photograph but slightly to the right. It is well formed, with a central peak, and is particularly prominent. South of it (above it on the photograph) is Clavius, which is, with the exception of Bailly, the largest crater on the visible part of the Moon; its diameter is over 140 miles. This whole area is crowded with craters of all sorts.

FIG. 9 (*top, right*). Dr N. Kozirev, the Russian astronomer who reported the disturbance in Alphonsus. Dr Kozirev is on the extreme left.

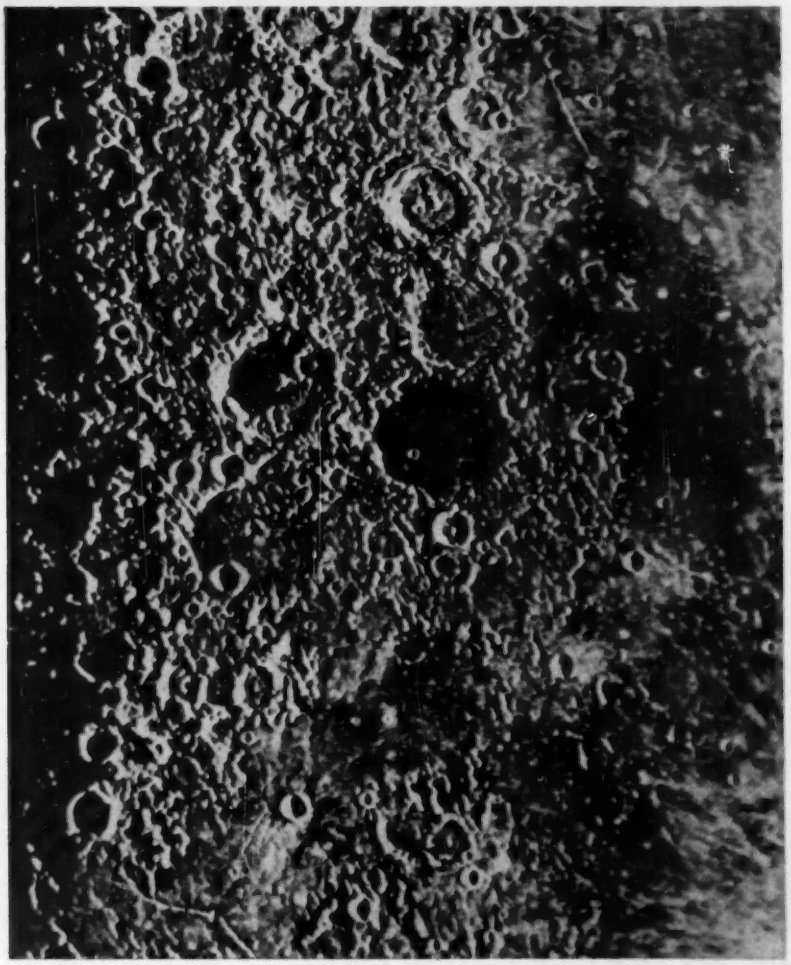


FIG. 10 (*right*). Part of the lunar surface. The large crater near the centre of the picture is Ptolemaeus; Alphonsus lies adjoining it on the south (above).

# RESEARCH AT LAKE KARIBA

**E. B. EDNEY**

*Professor of Zoology, University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia.*

*The creation of the 2000-sq.-mile headpond of the Kariba Dam involves changes which will provide unique opportunities of study for biologists, meteorologists, geologists, and sociologists. The University College of Rhodesia and Nyasaland is planning to build a laboratory for research work in the area.*

Primarily in order to supply electric power to the Federation of Rhodesia and Nyasaland, it was decided in 1955 to dam the Zambesi River at Kariba Gorge, about 100 miles upstream from the main Salisbury–Lusaka road crossing at Chirundu. Work began late in 1956 and the dam is now nearly complete. When all the electrical equipment is installed, the project will have cost £114 million and the largest man-made lake in the world, some 2000 sq. miles in area, will have been created.

The river was finally controlled towards the end of 1958 and by July 1959 the waters piling up behind the dam wall had already risen to 275 ft. above the original level at the dam site. This is still 120 ft. below the final level, and it is not expected that the lake will fill for another four or five years.

The existence of this large area of water will clearly bring about a number of changes—biological, meteorological, physical, sociological—many of which will provide unique opportunities for research. This article will say something of what is already being done, and draw attention to some of the fields for research which the situation offers.

First, a few words about the dam itself (see Figs. 2–7). The Zambesi River, which at the Victoria Falls, some 350 miles above the dam, is over a mile wide, is constricted as it runs through the range of hills at Kariba to a couple of hundred yards at full flood. Here the river is only 1200 ft. above sea-level, and the climate is hot and often humid.

The concrete arch of the dam is 420 ft. high (St Paul's Cathedral, London, is 365 ft. high) and nearly half a mile wide at the top. It will carry a 40-ft. roadway and have four flood-gates each of 30 ft.×31 ft. with a combined discharge of 230,000 cusecs. There are to be two power stations, the first of which will begin to operate early next year. This one is contructed in two vast underground halls (one for the machines, the other for transformers) in the south bank (Fig. 7). It contains five 100,000-kW. water turbo-generators with space for a sixth. The capacity of the complete installation will be 1·4 million kW.

The whole undertaking, situated as it is in one of the wildest, least developed parts of Africa, is already most impressive. As the lake rises, valleys are being flooded, and a number of islands, some temporary, others permanent are being created. African people living on either bank of the old river have been removed, animals trapped on the islands are being rescued, and harbours and roadways, suitable for the final lake level, are being constructed.

A little, but not nearly enough, was known about the climate, botany, zoology, and the people of the valley before flooding began. More information is being collected at present, although time is running out. What is already known will form an indispensable body of knowledge for future work, and to a consideration of these matters we may now turn.

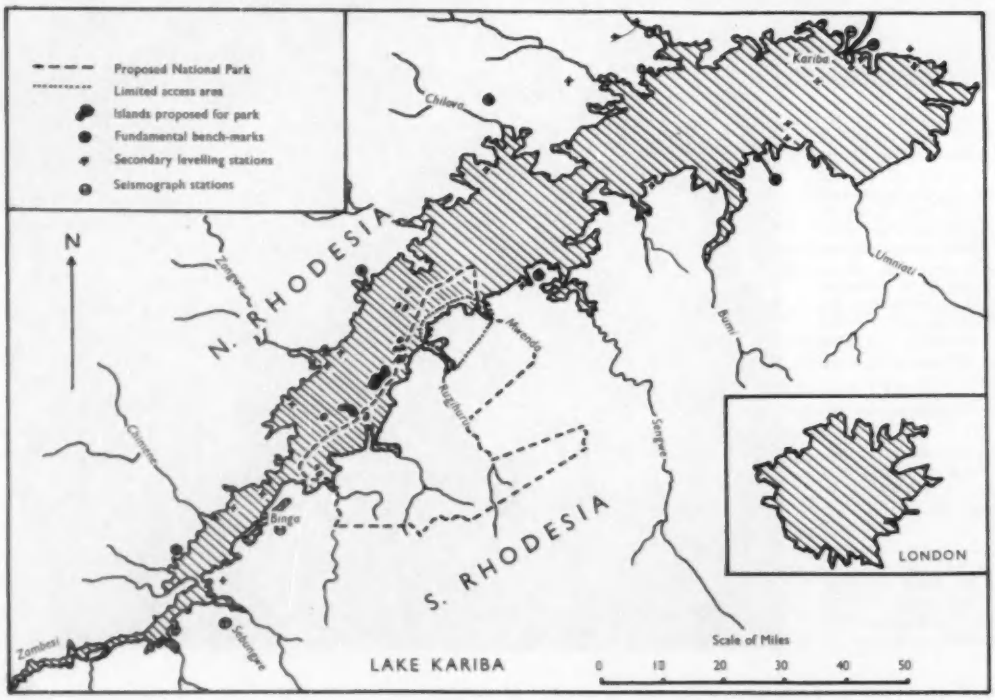



FIG. 1. A map of Lake Kariba, showing the proposed National Park and Research Reserve. (*Inset*) Greater London on the same scale.

FIG. 2. The Zambesi at low water, upstream from the dam, October 1958. This area is now flooded.

## GEOLOGY AND GEOPHYSICS

Although scientists in several fields have been caught unprepared by the rising waters, this is not universally true. Indeed, so far as geology is concerned, knowledge of the impending inundations stimulated Dr Bond of the National Museum of Southern Rhodesia to make a detailed study of the area—work which would otherwise not have been done for many years. It is not proposed to consider technical results in this article. Bond's findings are to be published[1] and they provide a noteworthy addition to our knowledge of African geology. In particular, the fault system of the beds beneath the lake are now well known.

For geophysicists the lake will provide unique opportunities for work of wide interest; for it will impose upon the earth's crust a load greater than any hitherto caused by man. When, in nature, a mountain occurs above the general level of the land, there is a balancing "root" of crustal material, which dips down into the denser subcrustal zone, and so provides a "float" to compensate for the extra weight of the mountain. An artificial mass such as Lake Kariba will, of course, have no compensating "root", and interest centres on the ability of the earth's crust to resist the new stress. A reasonable guess for the extra stress imposed by the lake shows that this is likely to be only from 1%–10% of the crustal strength. If, however, the crust is sufficiently weakened by faults, or if stress differences of 90%–99% of the strength already exist, fracture of the crust may result.

Realising this, the Department of Federal Surveys, directed by Brigadier M. O. Collins, has laid out a precise levelling network round and across the lake, including stations on islands, some of which will eventually be under water, but which will still be usable, so that later surveys will show any changes of level relative to adjacent areas. Three or four seismograph stations are also to be established round the lake so that earth tremors, if they occur, may be located. Dr Gough of the University College of Rhodesia and Nyasaland Physics Department is leading a group of workers interested in these matters.

## SOCIAL ANTHROPOLOGY

Those hydro-electric works which involve the creation of large areas of water also affect the local inhabitants profoundly. The Miguel Alemán system in Mexico, described by Nicholson,[2] is a case in point.

On either side of the Zambesi valley above Kariba Dam live the Tonga. Those who live in the low-lying valley have been subject to very little cultural impact (perhaps because of the forbidding environment and its diseases, floods, and droughts), and have remained a rather homogeneous, primitive group. The plateau Tonga, however, have seen migrations of Bantu tribes for centuries, and have been affected by admixtures from outside their own group; they are now distinct from the valley people, though both use a common language.

The valley people on both sides have been moved away

FIG. 3. An aerial view of the dam being built. Excavation is proceeding on the second stage coffer-dam. A temporary road bridge and suspension foot-bridge can be seen downstream from the dam. The Blondin cables which are used to transport 12-ton loads of concrete are above the dam. February 1958.

from the flooded areas. On the northern side, they have been moved in complete village groups to an area adjacent to the lake. This movement of people from one habitat to another is an experiment in human ecology and provides excellent material for the anthropologist. Fortunately, something was known of the culture of thse people[3] and, more recently, Prof. Tobias of Witwatersrand University was invited by Dr Desmond Clark, Director of the Rhodes-Livingstone Museum, to undertake further premigration studies on the valley people. This he did,[4, 5] and close on 200 observations were made upon each of a large number of individuals from the plateau Tonga and valley Tonga. The observations were physiological, physical, anthropological, genetical, nutritional, medical, and somatotypological. Fingerprints and photographs were used, so that in due course the same individuals in their own groups may be observed again and again, to find the effects of the new environment upon them. There is a likelihood that many will become fish-eaters in their new quarters, because fishing will be made easier by providing gear and encouragement. In the Zambesi valley, fishing was subject to the hazards of crocodile, hippopotamus, and other deterrents.

The studies of Tobias and his group may also throw light on the origin of the Tonga, about which very little is known, and thus upon the whole puzzling story of African prehistory.

## BIOLOGY

In the biological field, opportunities for research are many and attractive, though the ground has been less well prepared. Something is known of the zoology of the area since R. H. N. Smithers, Director of the National Museums of Southern Rhodesia, and his associates have been listing the birds, mammals, and reptiles that occur there. These and other data are being published as a series of "Kariba Studies".[6] Much information on the birds and mammals has been obtained by T. Scudder of Harvard. Thane Riney, a Fulbright research worker, and Graham Child are at present working in the area on the vertebrate fauna and the response of animals to floods.

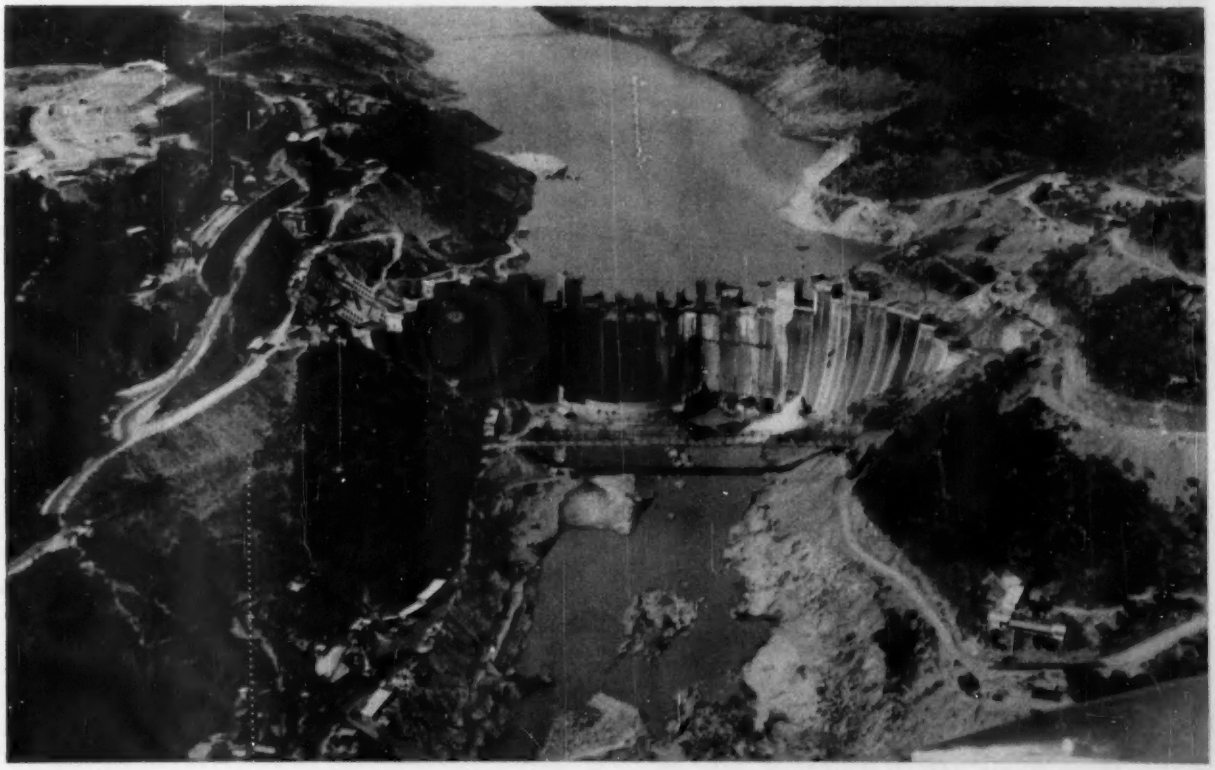
Something is known of the trees of the area as the result of a survey by G. M. McGregor, Director of Forestry, Southern Rhodesia Forestry Commission. The Southern Rhodesia Game Office and the Northern Rhodesia Department of Game and Fish have both been active in rescuing vertebrates from islands and flooded areas, and they have amassed much useful information on the natural history of these animals. Some are released, others sent to zoos, others again have to be killed, and the Zoology Department of the University College of Rhodesia and Nyasaland is carrying out parasitological work on these. Fish (*Tilapia* spp.) are being bred and put into the lake, and records are being kept of their subsequent behaviour.

Still within the biological field, we may now turn to consider the prospects for future work rather than what is being done. Lake Kariba lies approximately N.E.–S.W. (Fig. 1), and will provide an interesting contrast with Lake Nyasa, which lies nearly at right angles to it. For example, the effects of seiche movements and other phenomena may be compared in the two lakes. Kariba will be relatively shallow (about 400 ft. maximum depth compared with Nyasa's 2300 ft.) and the level is likely to vary annually through some 10 ft.–15 ft. Little or nothing is known about the probable physical properties of the lake, such as thermoclines, currents, wave action, oxygenation, and so on.

To follow the build-up of a brand-new lake such as this could be a fascinating field of work. What, for example, will be the succession of phyto- and zooplankton? How

FIG. 4 (*right*). The main dam wall rises across the Zambesi River. For scale, see the human figures on top of the wall. July 1958.

FIG. 5 (*below*). An aerial view of the dam after final closure. Lake Kariba is forming in the distance. January 1959.



will the bottom develop? How can the growth of fish best be encouraged and controlled? The Kariba Lake Co-ordinating Committee has appointed a fish ranger to work permanently in the lake area, stocking the lake with fish and recording data on the development of fish fauna, plankton, and water conditions. All this is extremely useful, but one man cannot possibly cope with all the problems, and a very great deal more needs to be done.

## BOTANY AND ZOOLOGY

For botanists, apart from the study of phytoplankton mentioned above, there are many attractions. It will, for instance, be possible to follow the changes in the flora of the lake shore brought about by the evolution of the lake. Much if not all of the local riverine vegetation will be flooded, but samples still exist elsewhere. Islands in the lake, if sufficiently isolated, may be used for the study of micro-evolution, and the effect of the rise and fall of the water level upon the shore flora is another field of interest. At present there are huge areas of the floating water fern *Azolla*, but the picture is changing all the time.

Zoologists will be interested in the zooplankton of the lake, and indeed in the whole of the fresh-water animal life. This is a vast field which urgently needs investigation. On the shores of the lake there is a rich fauna, including many large mammals (among which may be the rare white rhinoceros), which it is hoped will be reserved in national parks for study over long periods. There will be numerous islands in the lake, of different sizes and at different distances from the shore and from each other. Some of them will probably be large enough to support colonies of large mammals, and many may well support such animals as baboons. The islands provide excellent natural laboratories for work on behaviour, population dynamics, physiological ecology, and a host of other problems.

For example, some of the islands will contain tsetse flies. One of these could be cleared entirely by spraying, and a known number of flies of known age introduced. By subsequent trapping, that selection of a population which comes to various traps and in various physiological conditions could be established. This is information which would be impossible to obtain except where the composition of the total population is accurately known.

## RESEARCH RESERVES

For much of the biological work which can be done it is, of course, essential that observations be made over long periods in undisturbed areas. In other words, there must be reserves set aside for research purposes.

Recently, a meeting was held at the University College of Rhodesia and Nyasaland when most of the various research interests were represented. As a result of this, specific proposals for reserves are being made and it is hoped that an area of land and water, inside a national park, together with a number of islands, will be scheduled as research reserves (Fig. 1). The College will then seek funds to build and equip a laboratory and living accommodation on the lake shore for the use of its staff and of visiting scientists. It is also hoped to have a boat and hydrological equipment.

The College also wants to establish one or more research fellowships for work on Lake Kariba, so that the labora-

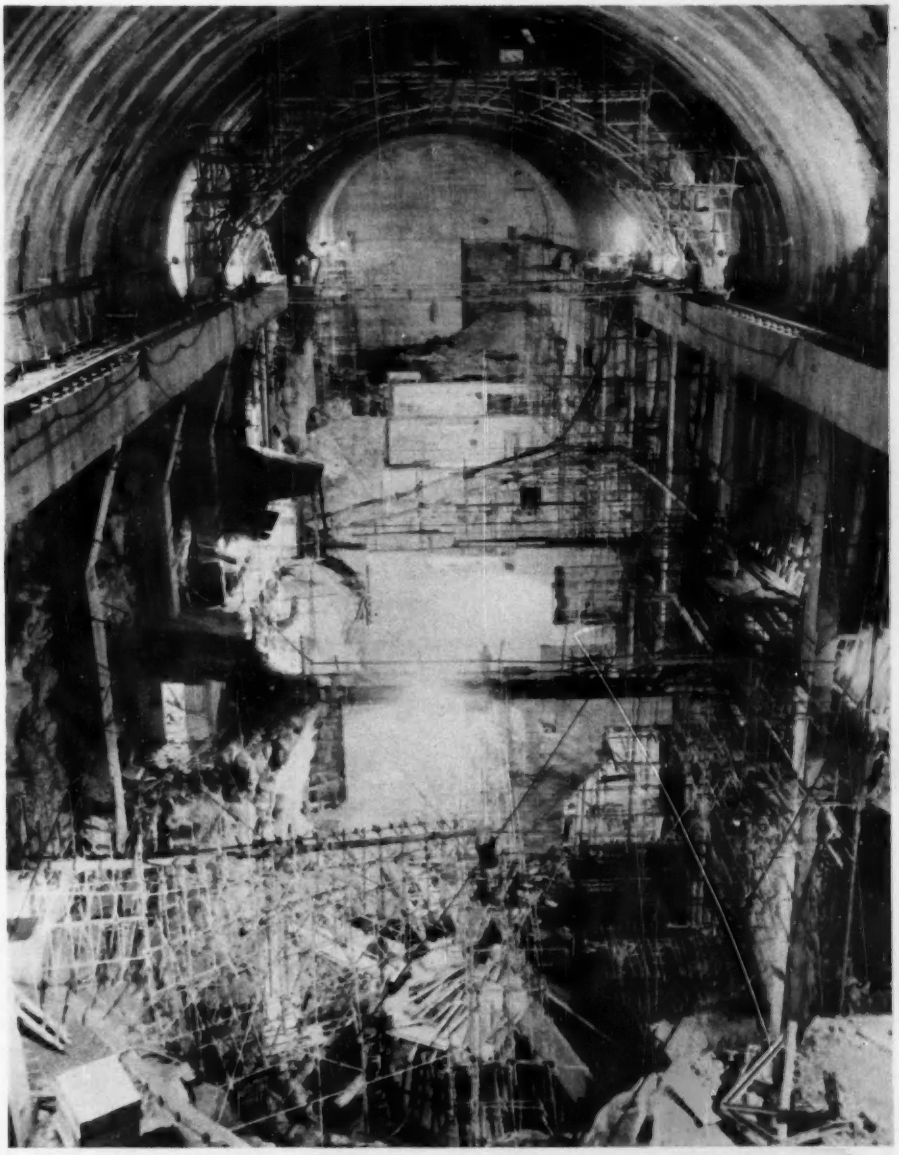


FIG. 7. The underground machine hall in the south bank, where six of the twelve 100,000-kW turbo-generators are to be housed. The hall is 488 ft. long, 75 ft. wide, and 132 ft. high. May 1958.
*(By courtesy of the Federal Power Board)*

FIG. 6. *(page opposite)*. A bushbuck doe, rescued from a flooded island, is tagged so that its movements may be checked. May 1959.
*(Figs. 2–6 inclusive are by courtesy of* The Rhodesian Herald)

tory will be continuously in use. This will permit the keeping of continuous records and will also lead to the accumulation of much local information of service to visiting scientists who arrive in the area for the first time.

If these ideas mature and the laboratory is successful, it may well develop into a sizeable research station, to which students and school classes could be taken for courses. The main consideration for the moment, however, is to gain financial support and the interest of scientists so that work can be started at the earliest possible moment.

I am grateful to the following for information in the above article in fields other than my own: Prof. A. S. Boughey and Dr D. I. Gough of the University College of Rhodesia and Nyasaland, Dr G. Bond and Mr Thane Riney of the National Museums of Southern Rhodesia. They are not responsible for the final statements, however.

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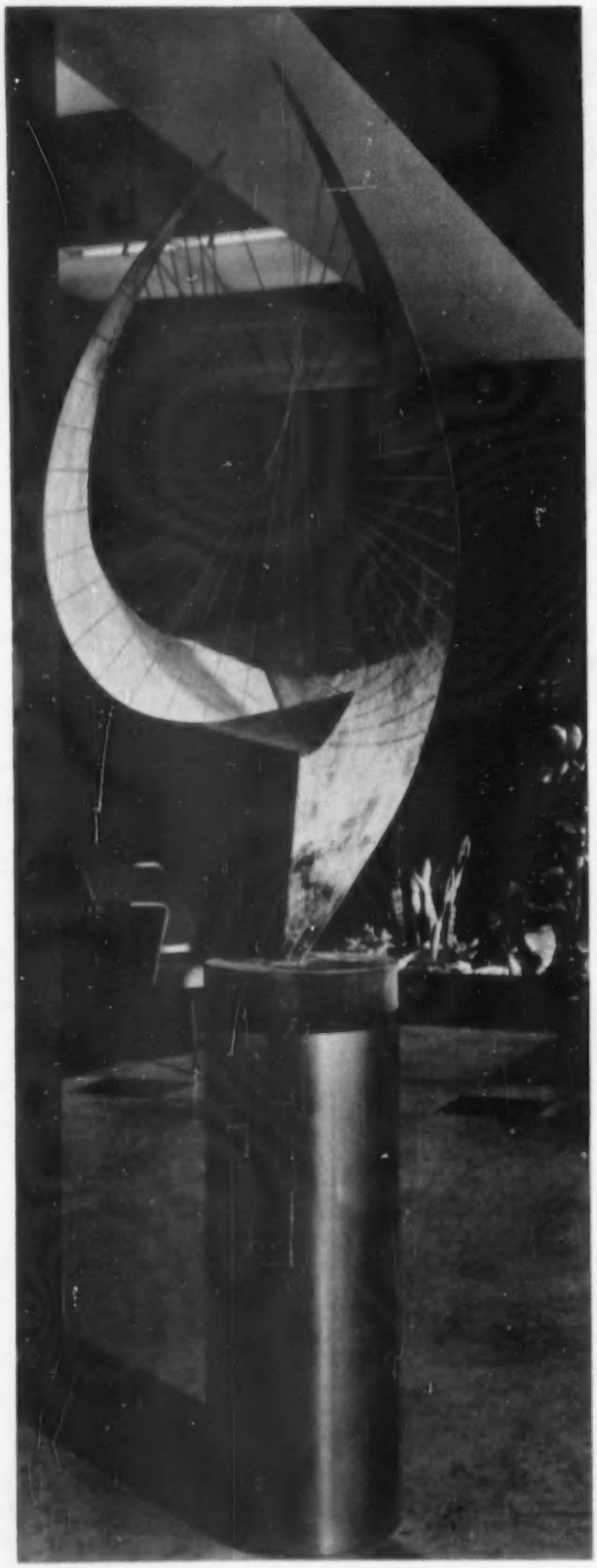
*Note.* The Kariba Studies Series is being published jointly by the National Museums of Southern Rhodesia, the Rhodes-Livingstone Institute, and the Rhodes-Livingstone Museum.



# INDUSTRY AS A PATRON OF THE ARTS

**PAUL REILLY**

*Deputy Director of the Council of Industrial Design, London.*

Industrial patronage of the arts can take many forms. In the 19th century it was more often than not a matter of last-minute conscience-money—manufacturers who had spent their lives turning out quantities of unsightly objects at great profit to themselves would spend their declining years endowing or enriching art galleries and museums; had they spent half as much time, trouble, and money on the design of the things they had made in their working lives they would have done better service to the arts. Today it is more often a matter of common sense, combined with a reasonable degree of public spirit—a company that wants to win respect takes care of its "public face" in all its visible manifestations from factory to point of sale, from the product to its presentation; thus the arts should become naturally integrated with commerce without straining after patronage. In any case, taxation would today normally remove the temptation or ability to add much to the nation's art collections, but even so there are some firms that manage to combine good design in their day-to-day activities with some more personal patronage of the fine arts; such companies have the good sense to commission paintings or sculpture from living artists with which to embellish their business premises or otherwise to enhance their reputation.

A good example of such intelligence being made clearly visible is to be found at the headquarters of Mullard Ltd in Torrington Place, London, W.C.1. Not only did this company commission Miss Barbara Hepworth to devise a piece of symbolic sculpture for the office entrance foyer (and got Sir Gordon Russell to unveil it) but it invited Roy Nockolds to paint a series of panels covering the services and products of the group (and got James Fitton, R.A., to open the exhibition of them). In both cases the company gave complete freedom to the artists to express in their different media the nature and impact of the modern technological character of the firm's pursuits; and few would deny that in doing so the directors of Mullards set a precedent that many of their contemporaries could usefully follow. To bring the artist into the office or factory, to relate his work to the unfolding excitement of scientific progress and to avoid hedging him around with preconceived, conventional notions of what art should be, is a rewarding exercise in the short term and, most probably, a profitable one in the long term, for good modern art has often proved a good investment to those who have had the courage to commission it.

FIG. 1 (*left*). Theme on electronics. A contemporary sculpture in brass by Barbara Hepworth.

FIG. 2 (*above*). A new research laboratory. The office block in the foreground is flanked by the two-storey laboratory building.

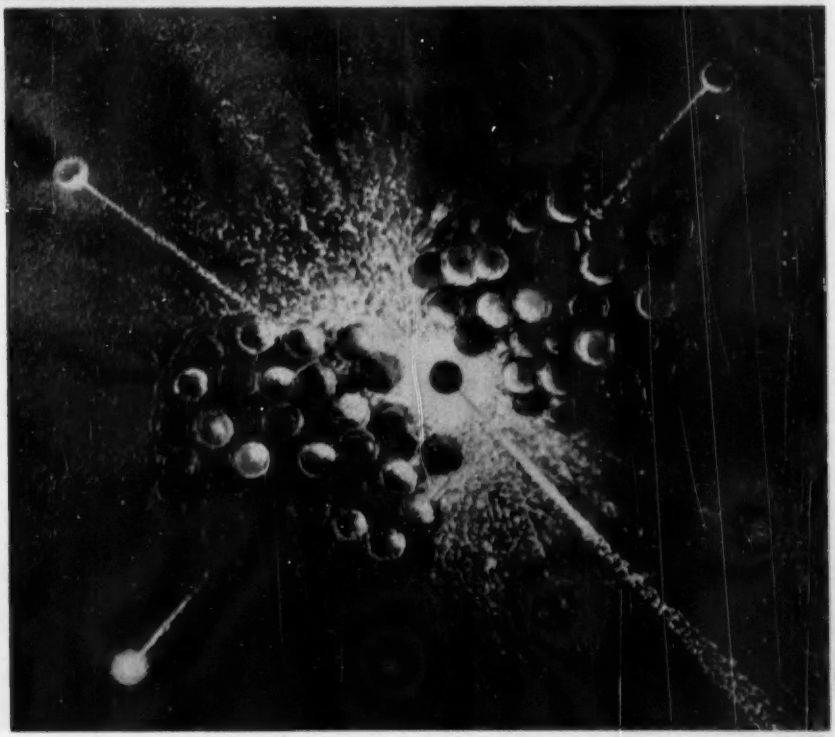


FIG. 3 (*right*). Nuclear fission. A painting by Roy Nockolds.

*(Photographs by courtesy of Mullard Ltd)*

# SOME EARLY APPLICATIONS OF PHOTOGRAPHY TO SCIENCE

HELMUT AND ALISON GERNSHEIM

*Today there is no branch of science which does not make use of photography, for the camera can observe and record that which is inaccessible to the human eye. Yet, the world's first photograph, taken in 1826, failed to interest the most eminent scientists.*

A few years ago Sir Robert Robinson, then President of the Royal Society, confirmed the opinion held by less distinguished people that photography is the greatest invention since that of the printing press. Indeed, modern civilisation would be quite unthinkable without photography, considering its thousandfold applications in science, industry, commerce, medicine, education, and entertainment, quite apart from its inherent qualities as an independent art medium.

The first photograph was taken in 1826 by a French landowner and amateur scientist, Nicéphore Niépce (1765–1833). It shows the view from his workroom at his estate, Gras, near Châlon-sur-Saône, and is on a pewter plate coated with bitumen of Judea. The exposure was approximately eight hours, resulting in the sun appearing to shine on both sides of the courtyard. Niépce brought this first successful camera photograph to London in 1827 but failed to interest the Royal Society in "Heliography". Two years later he entered into partnership with Daguerre, who, in 1837, succeeded in taking the first successful daguerreotype, with an exposure of about twenty to thirty minutes. The daguerreotype, publicly announced by Arago in 1839, was the first practical process of photography.

## PHOTOMICROGRAPHY AND LUNAR PHOTOGRAPHY

The earliest scientific application of photography was to microscopy. Two years before the publication of photography, the Rev. Joseph Bancroft Reade, F.R.S. (1801–70), had recorded images of the solar microscope on light-sensitive paper. The objects depicted in Reade's "solar mezzotints" of 1837 were enlarged 50 to 150 times in diameter. Fox Talbot, too, showed a few photomicrographs in January 1839. Dr Alfred Donné and Léon Foucault in Paris, and J. B. Dancer in Liverpool took the earliest photomicrographs on daguerreotype plates in 1840. In July, Dancer demonstrated at the Liverpool Mechanics' Institution a gas microscope of his own construction, through which he photographed a flea on a 7 in. × 5 in. daguerreotype plate. However, the earliest surviving photomicrographs are some taken by Joseph Delves by the wet collodion process in 1852 to illustrate his paper, "On the

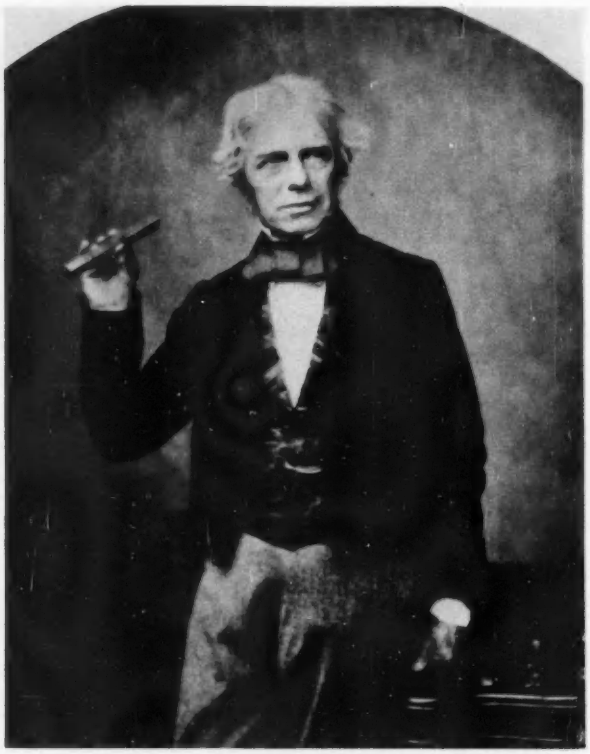


FIG. 1 (*above*). Michael Faraday. Photograph by Maull and Polyblank, about 1855. Faraday is holding a lead-borium silicate glass in an iron container which he used to prove the rotation of plane of polarisation by magnets and electric currents ten years earlier.

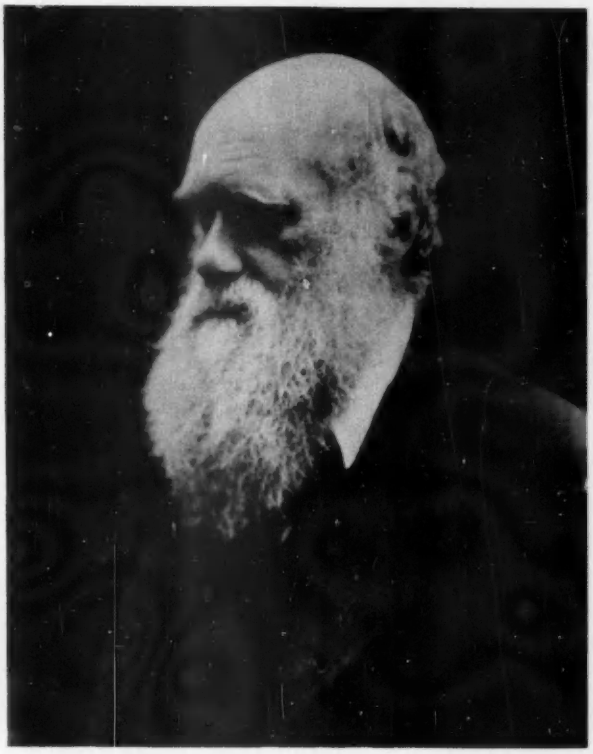


FIG. 2. Charles Darwin. Photograph by Margaret Cameron, 1869.

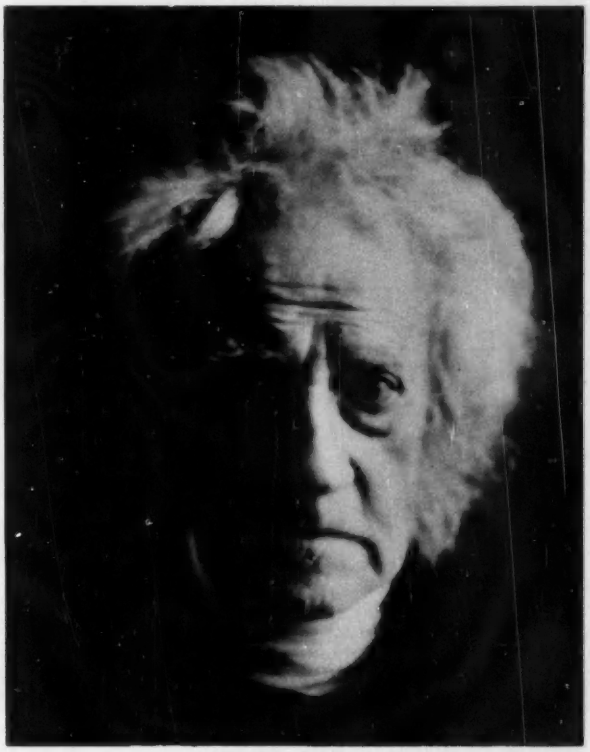
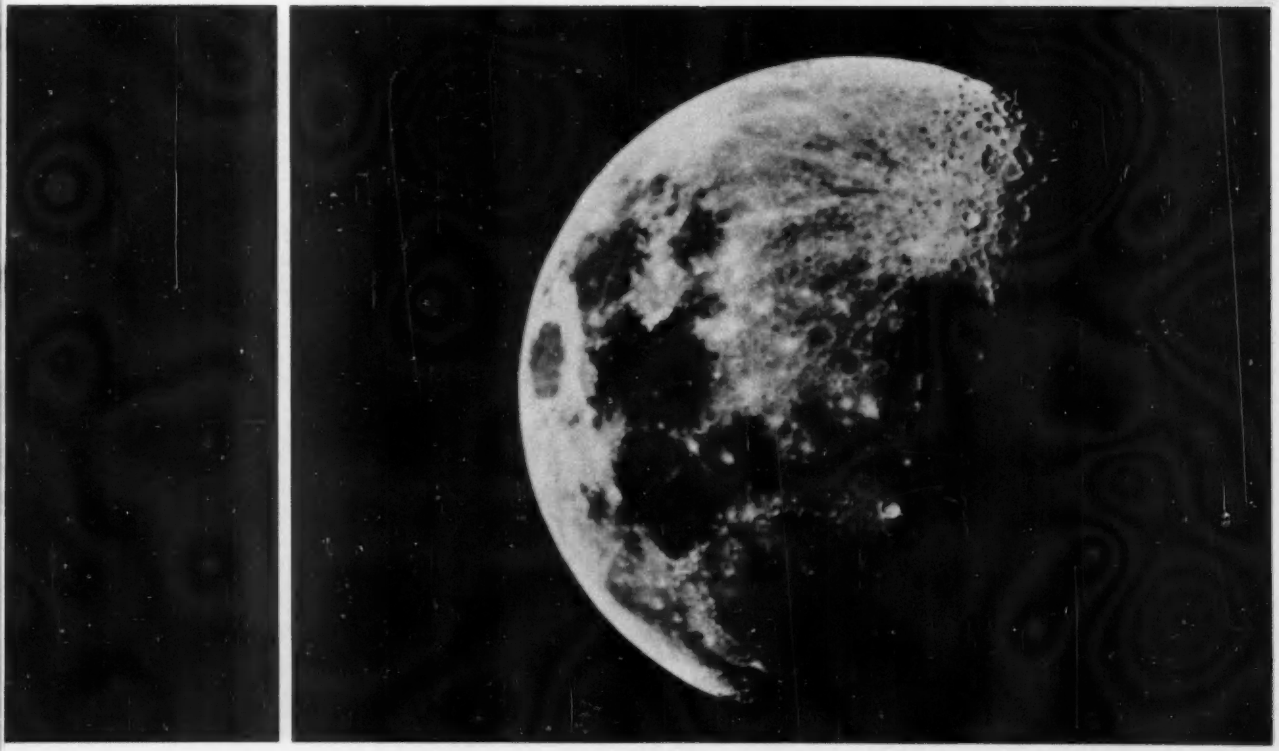


FIG. 3. Sir John Herschel. Photograph by Margaret Cameron, 1867.

FIGS. 4 and 5. A pair of stereoscopic photographs of the Moon, taken by Warren De la Rue, 1857.



application of photography to the representation of microscopic objects", published in the *Transactions of the Microscopical Society*, April 1853. The two illustrations show part of a silkworm ×60 and the proboscis of a fly ×180 (Figs. 6 and 7).

Since silvered copper plates give much better defined pictures than paper, a number of scientists in England, France, and America immediately tried to take a photograph of the Moon by the daguerreotype process. The first to succeed was Prof. John W. Draper of New York, who, on March 23, obtained a 1-in.-diameter image of the Moon with an exposure of twenty minutes. (In July 1842, Draper also took the first solar spectrum photograph. This well-defined image, which Draper sent to Sir John Herschel, measures 3·3 in. in length, and is preserved at the Science Museum, London.)

In 1857, Warren De la Rue, F.R.S., published a set of twelve photographs, each 2½ in.×2¼ in., showing different phases of the Moon, which were certainly the clearest and most detailed taken up to that date. At the same time he published a set of stereoscopic slides of the Moon, taken with an interval of a month between the pair of photographs in order to take advantage of the Moon's libration. These pairs of photographs when viewed in the stereoscope give the effect of the Moon's globe in relief, as though seen by a giant with eyes 52,000 miles apart. Herschel considered them "the crowning triumph of the stereoscope—a step out of and beyond nature".

## IN MEDICINE AND SURGERY

Photography in all its applications made enormous strides forward after the introduction of Scott Archer's wet collodion process in 1851. The following year Dr Behrendt of Berlin began photographing orthopaedic cases before and after treatment: this is the earliest application of photography to medicine that we know of. In 1854, Dr Hugh W. Diamond, superintendent of the Surrey Lunatic Asylum, published a series of photographic portraits of his patients, with brief medical notes, under the title, "Physiognomy of Insanity". In 1865–6, A. B. Squire published a set of photographs of diseases of the skin, and in 1871 there was founded in Philadelphia the bi-monthly *Photographic Review of Medicine and Surgery* illustrated with photographs.

In December, 1895, Prof. W. K. Röntgen (1845–1923) of Würzburg University published a paper, "On a new kind of rays", describing his experiments with the so-called X-rays which penetrate a large number of substances opaque to ordinary light. Röntgen's discovery was made accidentally during experiments with a Crookes vacuum tube contained in a cardboard box. It caused an enormous sensation, comparable with that aroused by the announcement of the daguerreotype.

Radiographical examination followed almost immediately: early in 1896 a Viennese physician detected a gallstone. One of the earliest diagnoses in Great Britain was the detection of part of a needle in a woman's finger, which was operated on at the Royal Free Hospital, London, at the beginning of March 1896.

Gradually other uses of X-rays were introduced: the detection of flaws in metal, the examination of paintings, and in crystallography. Apart from these serious uses,

FIG. 6. Photomicrograph of part of a silkworm, taken by J. Delves, 1852.

FIG. 7. Photomicrograph of proboscis of a fly, taken by J. Delves, 1852.

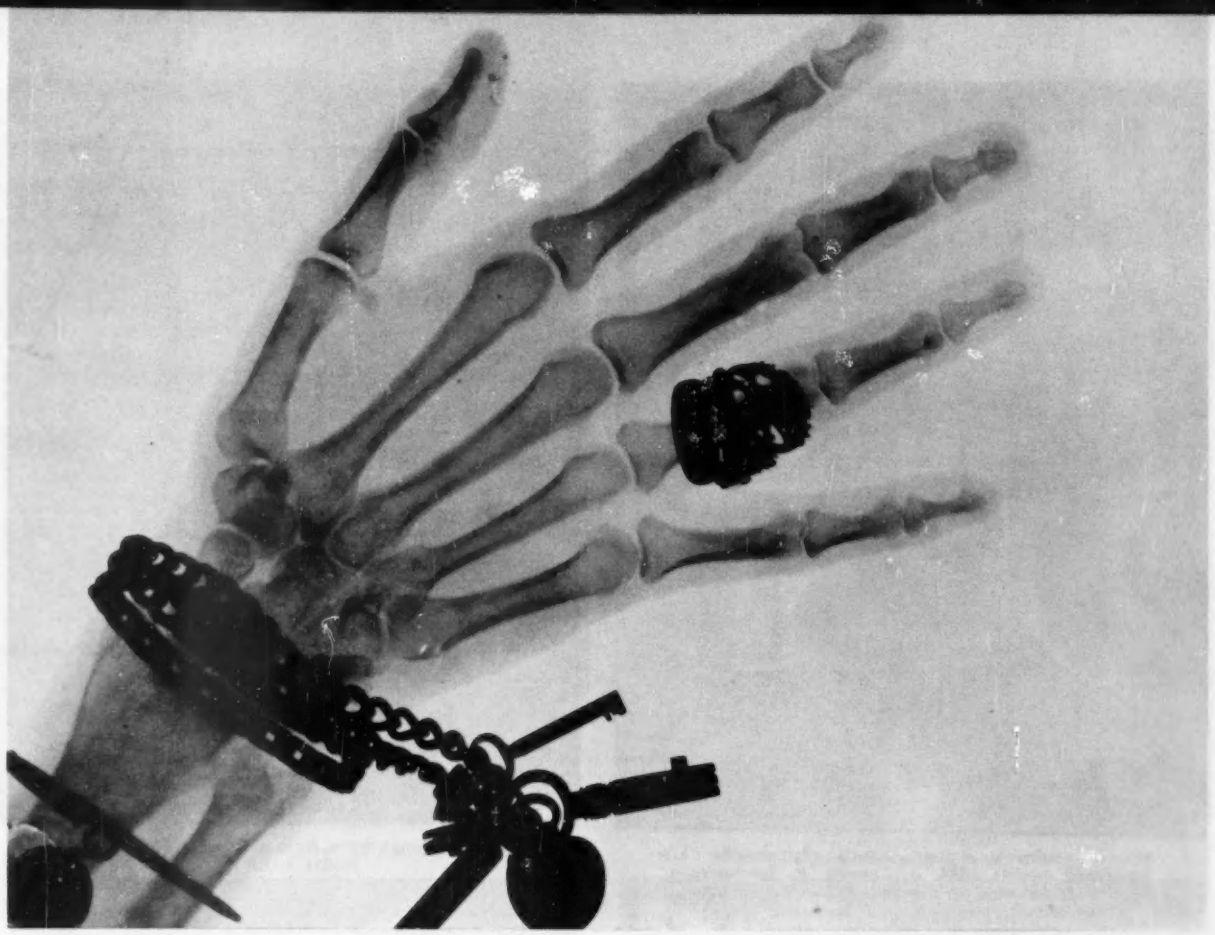


FIG. 8 (*above*). Early X-ray photograph of a hand, 1896.

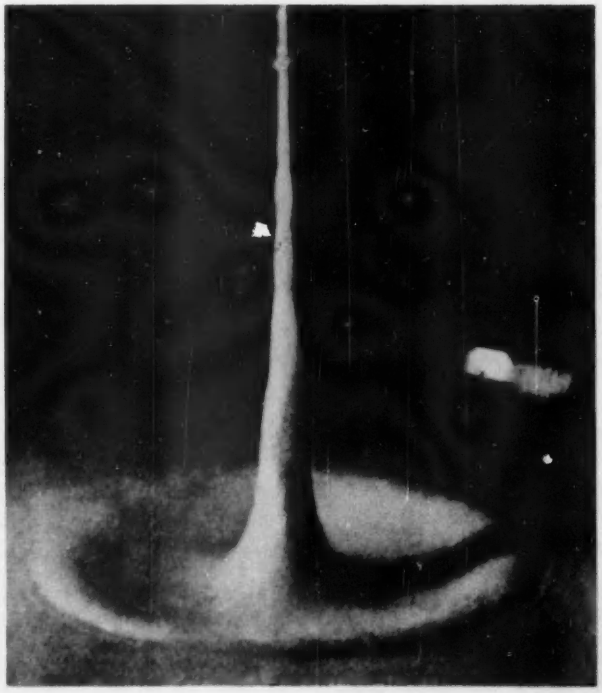


FIG. 9 (*below*). A milk splash caused by a falling ball, taken by A. M. Worthington, F.R.S., about 1900.

X-rays were in the early days an entertainment. Apparatus was installed in many a popular exhibition, such as one at the Crystal Palace. A favourite subject for demonstration was a hand wearing jewellery, or a purse containing coins.

## AERIAL PHOTOGRAPHY

It is just over a hundred years since the first successful aerial photograph was taken by the French portrait photographer and balloonist Nadar, who, foreseeing that aerial photography was bound to revolutionise ordnance survey and military reconnaissance, took out a patent for "an entirely new system of photography, whereby photographic bird's-eye views of portions of the earth's surface may be taken". The camera was not on a tripod as shown in one of Daumier's caricatures punningly entitled, "Nadar raising Photography to High Art", but was firmly fixed in the side of the balloon car (for angle shots) or vertically in the bottom of it. A darkroom was incorporated in the balloon car, since with the wet collodion process the plates had to be coated, exposed, and developed on the spot. Nadar took several bird's-eye views of Paris from a captive balloon at heights of up to 1500 feet in 1858–9, but results were unreliable, for the plates were not fast enough to counter the balloon's movement. Nadar was therefore unable to fulfil his plan to map the whole of France from the air. Despite isolated successful results in later attempts, aeronautical photography could make no real progress

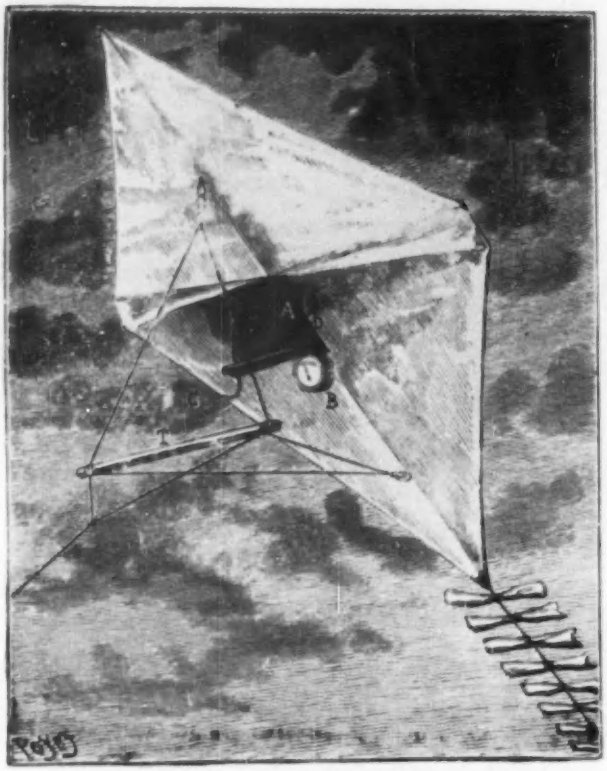



FIG. 10 (*above*). Arthur Batut's photographic kite (improved model), 1888. *A*, Camera. *B*, Barometer. *C*, Shutter. *D*, Housing for mirror to reflect barometer reading on to photographic film. *T*, Kite stabilising rod.

FIG. 11 (*above*). Paris from a balloon. Photograph by Nadar, about 1859.

FIG. 12 (*below*). Kite photograph of Labruguière, France, taken by Arthur Batut on March 29, 1889.

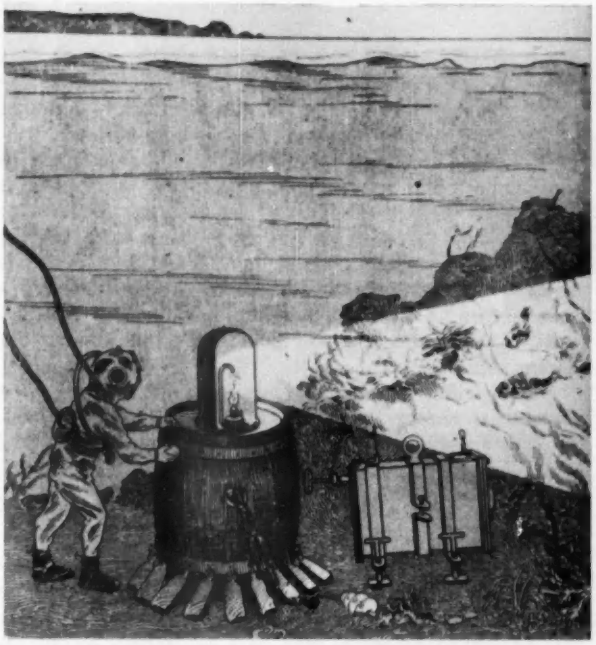


FIG. 13. Louis Boutan's method of photographing underwater by magnesium light. About 1893.

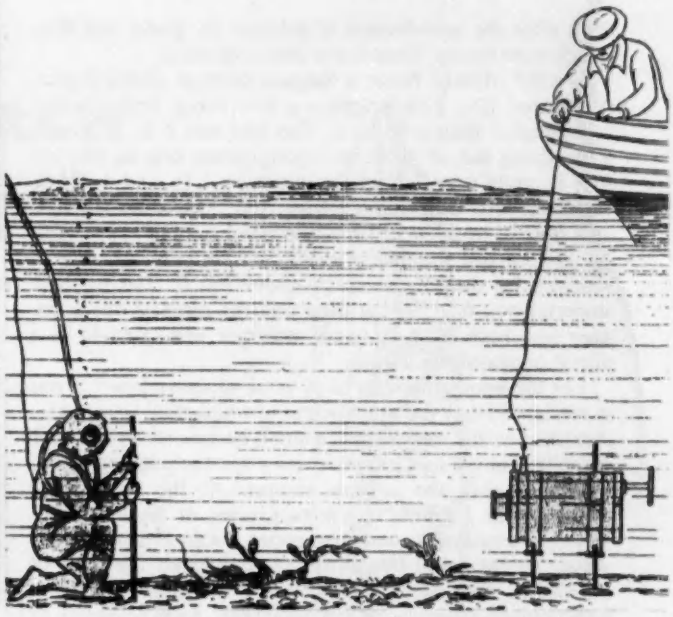
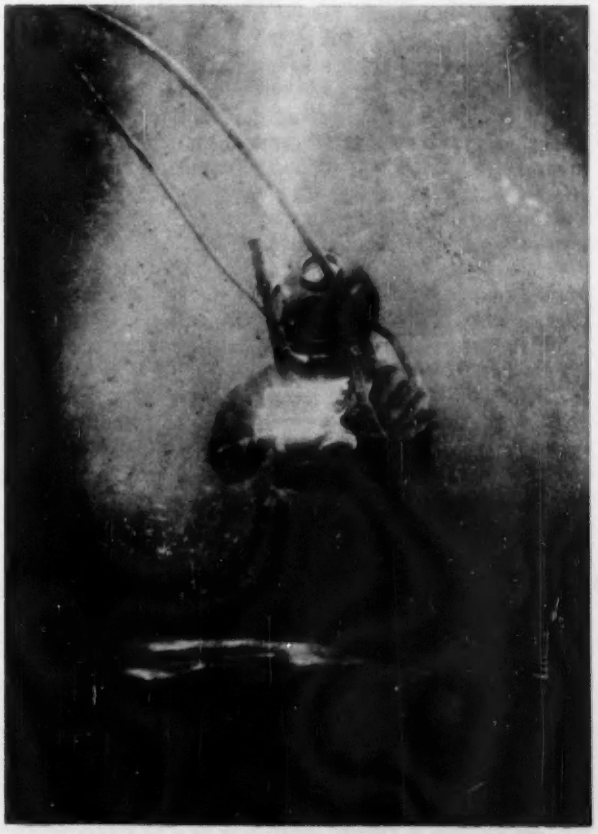


FIG. 14. Wood-cut to show how underwater photograph of Louis Boutan (*below*) was taken.

FIG. 15. Sea anemone by Louis Boutan.

FIG. 16. Louis Boutan.
*(All photographs from the Gernsheim Collection)*



until after the introduction of gelatine dry plates and film, which were twenty times faster than collodion.

In 1887, Arthur Batut, a Belgian amateur photographer, introduced kite photography—a kite being both cheaper and steadier than a balloon. The kite was 8 ft. long with a steadying tail of 39 ft. Its raising-power was so efficient that it could carry apparatus weighing 4 lb. and a 725-ft. tethering cord weighing a further 4 lb. The camera shutter was opened by a tinder time-fuse which was lit at the take-off and burned for four minutes; it took only a couple of minutes for the kite to reach about 260 ft. The negative material was flexible, cut film, and the moment the exposure had been made a paper streamer was released as a signal to haul down the kite.

For the photographs to be of value to the surveyor it was essential to know the exact height at which they were taken. Attached to the camera was a small barometer with a dark chamber behind its glass dial, and a shutter working simultaneously with the camera shutter. At the moment of exposure the shadows of the two hands of the barometer were projected on to sensitive paper. From this record the actual height could be calculated, and hence the scale of objects in the photograph. Batut's kite photograph of Labruguière taken on March 29, 1889, from a height of 300 ft. proves that his apparatus was efficient.

## UNDERWATER PHOTOGRAPHY

Today a popular sport as well as an important aid in marine engineering and biology is underwater photography, first attempted in 1856 by William Thompson, an engineer at Weymouth. He constructed a watertight box to contain the camera, which was clamped to a heavy iron tripod and lowered from a rowing-boat on to the sea-bed 18 ft. below. The drop shutter was held open for ten minutes by pulling a long string from the boat. In spite of leakage of sea water into the camera, Thompson succeeded in developing a passable picture of seaweed and sand.

Ten years later a French photographer named Bazin took sharp photographs of sunken objects by electric light from a Bunsen battery. Bazin went down to the sea-bed in a kind of diving-bell, a sheet-iron box with watertight port-holes, through which he photographed. His purpose was to make the reclamation of sunken ships easier, and he could safely remain in his submarine studio for about ten minutes at depths approaching 300 ft.

About 1893, Louis Boutan, professor at the Zoological Station at Banyuls-sur-Mer in the eastern Pyrenees, went down in a diving-suit to explore the sea-bed with a magazine camera containing six gelatine dry plates. The whole was sealed in a watertight metal box with glazed openings for the lens and viewfinder. Exposures of ten to thirty minutes were necessary, depending on the depth. Since waterproof watches had not yet been designed, Boutan signalled on the safety rope to a man in the boat when the exposure began, and he in turn signalled in the same way when the time was up. Manoeuvring the cumbersome apparatus was very exhausting until Boutan had the idea of attaching it to a barrel of air acting as a float. Below 15 ft. artificial light was necessary. Boutan's method was to take down a 50-gallon barrel full of air supplemented with oxygen, having at the top a lighted spirit lamp under a glass dome. Into this lamp magnesium powder could be injected through a rubber tube, to give a brilliant, short-lived light, seven-eighths of which, nevertheless, was absorbed by the sea water at a distance of about 35 ft. For photographing fish in fairly shallow water Boutan took down a white background and scraps of food to scatter in front of it. At great depths only sea-scapes such as close-ups of anemones and seaweed could be taken. Boutan had a photograph of himself taken by his assistant in the boat; the woodcut, Fig. 14, shows how it was done. In 1899, using a more ambitious lighting system of submarine searchlights charged from a dynamo on board a sailing-boat, and a camera with an electromagnetic shutter operated from the boat, instantaneous pictures could be taken and greater depths explored.

Great strides have been made since the first book on underwater photography was published in 1900 by Boutan. In it he prophesied that one day underwater photography would be practised by amateurs and become a new sport.

## COMPOSITE PORTRAITURE AND HIGH-SPEED PHOTOGRAPHY

A supposed scientific theory which proved to be unfounded was that of Sir Francis Galton, F.R.S., the invention of photographic composite portraiture, first propounded in *Nature* in May 1878 and further elucidated in his pioneer work on eugenics, "Enquiries into Human Faculty" (1883). Galton's idea was to photograph in the same position all the members of a family, or a number of representatives of any group of people such as scientists, cab-drivers, schoolgirls, criminals, and so forth, the portraits being superimposed on the negative. The resulting (single) composite portrait was supposed to show the type of that class. In fact, irregularities of feature cancelled each other out and the composite portrait was invariably better-looking than the originals. A group of criminal lunatics produced a rather pleasant and noble countenance both in feature and expression, which could easily have passed for a somewhat blurred but by no means unflattering portrait of a clergyman.

In these days of high-speed photography the pioneer work of Lord Rayleigh, F.R.S., Prof. A. M. Worthington, F.R.S., and Prof. C. V. Boys, F.R.S., seems worth recalling, for they had already made the public familiar with high-speed photographs taken at one-millionth second exposure in the 1890s. Boys's favourite subject was flying bullets, Rayleigh's bursting soap-bubbles, while Worthington specialised in all forms of splashes. The light source was the spark of a Leyden jar, and the splashes show not only the downward momentum of the drop or ball, but also the upward surge of displaced liquid, first forming a corona round the displacement and then rising in a straight column. Prof. Worthington published his earliest results in "The Splash of a Drop" (1895) and a more detailed study in 1908. Since 1933, Prof. Harold E. Edgerton and Kenneth J. Germeshausen of the Massachusetts Institute of Technology have developed this particular branch of photography still further, taking multiple exposures by stroboscopic flashlight, and achieving finer pictures.

Photography has indeed rendered a great service to science in the hundred years that have elapsed since the work of the precursors described above. In its second century photography will no doubt produce further proof of its versatility, accuracy, and ability to extend the limited vision of the human eye.

# GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

FIG. 1. The first detailed sectional engineering drawing for Australia's radio-telescope. Note easy access to the radio focus via a lift in one of the support arms, enabling easy servicing and the speedy change-over of aerials.
(*Specially drawn for* DISCOVERY *by Freeman, Fox & Partners*)

### Largest Emulsion Ever Made

A 10-million-cu.-ft. balloon will be launched above the Equator in January by Dr Marcel Schein of the University of Chicago. The two largest stacks of nuclear emulsions ever made are to be flown from the balloon at about 20 miles high. Each stack will measure $24 \times 18 \times 12\frac{1}{4}$ in. and will be made up of 200 sheets specially prepared by Ilford emulsion chemists. They will probably be collected by an American naval vessel from Ilford's London laboratories towards the end of this year. The casting of the emulsions is expected to start this month.

Dr Schein hopes to detect some previously unobserved atomic particles and events through the bombardment of primary cosmic rays near the top of the atmosphere on this great volume of emulsion. Perhaps anti-matter may be observed for the first time outside the laboratory. Dr Schein is appealing to all institutions with experience in scanning emulsions for nuclear events to assist in reducing the huge volume of information to be gathered. About twenty institutions are involved. The total cost of the project is £200,000, to which the cost of the emulsions contributes £4000.

### Australian Giant Dish Ready by 1961

How to have the most accurate large radio-telescope in the world at a cost of less than £1 million? This was the dilemma before the Radiophysics Division of the Commonwealth of Australia's Scientific and Industrial Research Organisation (CSIRO) four years ago. The solution has been found through the expenditure of a great deal of time, effort, and ingenuity in the design stages of the telescope, which began in 1956. It is expected that the actual construction of the instrument (despite its size) will take up only a third of the total time spent on the project.

Plans for the realisation of the telescope took a significant step forward this summer. The main contract was placed on July 10, 1959, and provides for completion within twenty-one months—that is, early in 1961. The prime contract, worth £A600,000 (£480,000), has been awarded to the West German steel firm of Maschinenfabrik Augsburg Nürnberg A-G (MAN). Various important components of the instrument are being subcontracted to British firms and elsewhere.

Messrs Freeman, Fox & Partners of London have been the consulting engineers throughout, first making a feasibility study of large radio-telescopes, and then preparing the detailed design for the CSIRO instrument as now adopted. The firm has been retained to supervise its construction and commission. The design and construction of the radio and electronic receiving equipment is being undertaken by the Radiophysics Division.

The achievement of this great project is largely due to the dynamic leadership of Dr E. G. Bowen, O.B.E., whose Division of Radiophysics has won for itself a high reputation in the field of radio-astronomy.

The total cost of the radio-telescope and its associated facilities will be about £A750,000. Half of the total funds required have been raised through generous grants from the Carnegie Corporation of New York and the Rockefeller Foundation, and from private benefactors in Australia. The remaining sum has come from the Australian Government.

The new radio "dish" will make a magnificent addition to the various radio-astronomy equipments which have been in successful operation by the CSIRO in Australia for some time. These include "telescopes" of the interferometer type—for instance, the "Mills Cross" and "Chris Cross" (or crossed-grating interferometer), which have revolutionised techniques in this highly esoteric science. The reflector of the new instrument will be 210 ft. in diameter. This is somewhat smaller than the 250-ft. paraboloid at Jodrell Bank, Cheshire, but both the surface accuracy and the pointing accuracy of the Australian instrument will be substantially higher. The design of the instrument, the work of Freeman, Fox & Partners, bettered the original requirements by about 50% enabling full operation down to a wavelength of 20 cm. at least and possibly as low as 10 cm. (3000 Mc/s). It is likely to be the most precise and powerful equipment available for use at hydrogen-line frequencies for some time to come. The design enables several aerials to be used simultaneously, so making it possible to observe on a number of frequencies at the same time. The surface of the dish is to be of fine wire mesh rather than of solid metal plate, as has been the practice with many earlier designs.

The dish itself will be mounted in alt-azimuth fashion on top of a reinforced three-storey concrete tower about forty feet high (see Fig. 1). The dish and steel superstructure together will weigh 800 tons, and will be moved and controlled in a novel and ingenious manner. By comparing optically the direction in which the dish is pointing with that of a precise, equatorially mounted optical device, the "error signals" developed are made to operate a servo-controlled drive to align the large radio reflector with the easily moved, precisely pointing optical instrument. The pointing and following accuracy of the servo-drive system has thus been held within the few seconds of arc specified; it had been proved very difficult to achieve this in any other way. It is confidently expected that the total pointing errors from all sources will not exceed one minute of arc in a 20-m.p.h. wind. This master-equatorial system has been developed under the direction of Freeman, Fox & Partners from an original idea conceived in mechanical terms by Dr Barnes Wallis of "dam-buster" fame. The new radio-telescope's principal use will be for radio-astronomy. A proportion of the working time may also be devoted to the tracking of space probes, and a transmitter could be fitted so that radar measurements might be made. The telescope's facilities will be available to any scientist from Australia or overseas who has a problem for which it is particularly suited. The geographical position of the instrument will enable observations to be made of much of the northern sky as well as of the whole of the less-documented southern heavens. The site is near Parkes, a country town 200 miles from Sydney, where the electrical interference is exceptionally low.

An approximate breakdown of the MAN contract follows:

| | £A |
|---|---|
| Steel structure (MAN) | 269,000 |
| Mechanical gear (MAN) | 76,000 |
| Servo-drive and control (AEI Ltd, lately Metropolitan-Vickers) | 86,000 |
| Master-equatorial control (Askania Werke A-G, Berlin) | 64,000 |
| Foundations and concrete tower (Australian subcontractor) | 56,000 |
| Miscellaneous facilities | 49,000 |
| | £A600,000 |

### "Long-playing" Space Probe

The oddest-looking object yet launched into space also promises to be the cleverest and most useful so far. America's 142-lb. "paddlewheel" satellite, launched August 7, combines some of the range of a space probe with the long life of an earth satellite. The satellite has been dubbed the "long-playing rocket"; so this vehicle may be considered the first of the "long-playing" space probes. Its immediate successor, tentatively scheduled for this month [October] is intended to loop the Moon. Its ultimate successor is destined to reach the vicinity of Venus, a journey that will take three months to cover by rocket.

It represents the first full flowering of the new American civilian space agency's policy. This acknowledges that it is no good spending enormous sums loosing a rocket into space (whatever the temporary prestige value) if the vehicle's radio is

silent when it reaches its destination. So far, no rocket radio has been heard from beyond some 4 million miles away. This is past the Moon, but only a seventh of the distance to Venus. The two new Sun satellites' radios had ceased to be heard long before they entered orbits round the Sun. They might have produced some fascinating information otherwise.

The obvious way to keep up radio power is to use the abundant energy available in space from the Sun to trickle-charge the batteries. The sides of the four 20 × 20-in. "paddles" extending out round the satellite's waist are studded with 8000 silicon-based solar cells, arranged so that 1000 are always in direct sunlight. The solar cells alone are understood to have cost $1,000,000.

To make sure the maximum information is recovered from the fifteen interrelated experiments aboard, the telemetry arrangements are in triplicate. Two lower-power transmitters signal back results continuously (on 108·06 and 108·09 Mc/s respectively) in the standard manner. A high-power transmitter operating on an undisclosed ultra-high frequency releases the data in a digitalised form on command from the ground. This system involves a computer with memory units aboard the satellite. It is apparently working admirably and the strength of the signal received from this primary system on command is an enormous advance on those of previous space vehicles. It will need to be. Data from the vicinity of Venus will have to be radioed more than a hundred times farther than data from the Moon.

The power requirement for the UHF primary transmitter system is 40 W. By comparison, no other equipment on board the satellite, including the two low-power transmitters, requires much in excess of 1 W. Most of it runs on less than 1 W. The high-power transmitter accordingly is only operated for 1½ hours in six, enabling the solar cells to recharge the chemical storage batteries in the meantime. This transmitter is switched on and off, as appropriate, by radio command from one of several selected ground tracking stations. A team at Jodrell Bank, Cheshire, gained the first honour. The high-frequency receiver on the satellite is, in fact, able to activate thirty distinct switches and so adjust thirty distinct parameters within the vehicle, on ground command. One could have fired a "kick-rocket" to speed up the satellite at perigee and so lift its orbit as a whole farther from the Earth's surface if the launching had not been quite accurate. This device was for use if perigee had proved lower than 100 miles high, giving the satellite a very brief life. The launch was faultless, however, placing the satellite in a path that carries it from 140 miles to nearly 23,000 miles out, so the kick-rocket was not required. The satellite is expected to be up for twenty years and its radio to last for at least one year.

To achieve this unusual and difficult orbit a capacity for a velocity of 22,000 m.p.h. was given to the boost rocket combination. This is some 4000 m.p.h. in excess of the standard orbital velocity attained by previous earth satellites (18,000 m.p.h. or thereabouts).

As the new satellite loops from about 140 to 23,000 miles out into space, it is carried through both zones of the Van Allen radiation discovered by the early *Explorer* satellites. (This satellite is officially called *Explorer VI*.) It is logical therefore that the main group of experiments carried are concerned with radiation in space and the Earth's magnetic field which shapes this (see table below). Three different types of radiation instruments are carried so that different energy ranges can be measured, including those of the cosmic rays. By the end of the year during which the satellite is expected to relay information there should be little left unknown about the still rather mysterious radiation belts and about other radiation hazards to spacemen.

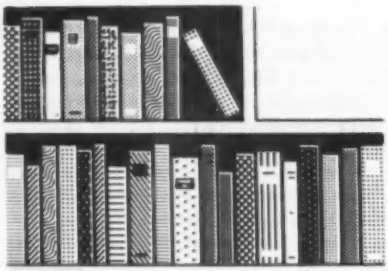
The other large group of experiments is concerned with the propagation of radio signals below, through, and above the ionosphere, and is linked with the satellite's role in pioneering radio transmissions over the great distances required for the efficiency of the space and planetary probes to follow it. Little detail has been released about these experiments but it is known that a wide range of frequencies are under observation; that one of the experiments is concerned with the very low frequency naturally occurring and as yet incompletely explained "whistler" atmospherics; and that this experiment makes use of a VLF signal specially broadcast from the powerful Navy transmitter at Annapolis, Maryland, which is then re-broadcast to tracking stations automatically from the satellite.

Work on the "paddlewheel" satellite programme and Venus probe began last November under NASA contract to the Air Force Ballistic Missile Division. BMD sub-contracted to the Space Technology Laboratories Inc., Los Angeles, for systems-engineering, technical supervision of payload, tracking and communications, and the launching vehicle (*Thor-Able III*).

The following table sets out the components of the payload and their respective weights in greater detail.

**Components of Instrument Package (142 lb.) and Weights where known**

| | lb. |
|---|---|
| **Power** supply system (including storage batteries) | 30 |
| **"Kick" rocket** (not fired) | 5 |
| **Primary transmitter** (UHF), digitaliser and "memory" unit | — |
| 108·06 Mc/s **low-power transmitter** (analogue telemetry) | — |
| 108·09 Mc/s **low-power transmitter** (duplicate analogue telemetry) | — |
| **HF receiver** commanding 30 distinct "onboard" switches | — |
| **LF "transponder" receiver** used as tracking guide and for Stanford University "whistler" radio experiment | — |
| Cloud cover open-lens scanning **camera** and electronic counter | 2½ |
| Rotating-coil **magnetometer** to measure Earth's field (Space Technology Laboratories experiment)<br>Fluxgate **magnetometer** to measure another geomagnetic component (STL) | 3 |
| **High-energy radiation experiment** composed of 6 proportional counters arranged about a seventh counter, all lead-shielded. (University of Chicago experiment) | 4 |
| **Medium-energy radiation experiment** consisting of ion-chamber (to give total radiation) and Geiger counter to measure flux. (University of Minnesota experiment) | 2 |
| **Low-energy radiation experiment** using a scintillation counter. (Instrumented by the Space Technology Laboratories) | 3 |
| **Micrometeorite experiment** employing two shielded microphones. (Air Force Cambridge Research Centre) | 1 |
| **Angular accelerometer** to register "tip-off" angle of rocket stages and indicate if satellite develops wobble or tumbling | — |
| **Voltage gauge** and control unit to check solar cell output and adjust charge rate to chemical batteries | — |
| | 50½ |



# THE BOOKSHELF

*Academic freedom is one of the greatest treasures of mankind. It was fought for in the Middle Ages and again in recent times and it is still not yet firmly established in all parts of the world.*

**A Defence of Free Learning**

By Lord Beveridge (*London, Oxford University Press, New York, Toronto, 1959, 146 pp., 18s.*)

Lord Beveridge, as he tells us, has very suitably chosen the title of his book from the appeal issued over the signature of Lord Rutherford, when, in March 1936, it became advisable to reconstitute, as the Society for the Protection of Science and Learning, an organisation of more permanent structure and with duly appointed trustees, what had till then been the Academic Assistance Council. That Council had come into existence three years earlier, primarily on Lord Beveridge's own initiative. He recalls a visit which he made to Cambridge at that time, to discuss the urgent need for such an organisation, the week-end discussion which he had accordingly with George Trevelyan, Frederick Gowland Hopkins, and Rutherford, and his success in persuading Rutherford, against some initial reluctance, to become its first president. And thus he was able to launch the proposed appeal with the backing of a very impressive array of signatures, mostly of leaders of various departments of scholarship and science in British universities. The object was, of course, to obtain immediate relief, and a prospect of renewed opportunity for research, even on an emergency basis, for the growing stream of eminent scientists and scholars from German universities, who were being deprived and threatened by Hitler on account of Jewish parentage or ancestry, or even on suspicion of political antagonism to this fanatical savagery, and who, on fleeing from the terror to find refuge in Britain, or other free countries, were allowed to take no more than 10 marks each, for their support.

The appeal had been addressed primarily to the academic staffs of British universities, though private appeals were also and naturally made, with varying success. With Rutherford as president, Beveridge himself became the first honorary secretary, and soon found the need of a colleague with time enough to take a major share of this honorary secretarial work. He records that he was at the time in sympathetic correspondence with the Royal Society, and that the Royal Society Council recommended to his notice, in that connexion, the late Prof. C. S. Gibson. I suppose that, as one of the Society's two secretaries at that time, and the one most likely to deal with such a recommendation, I ought to have remembered it. My plate, however, was pretty full then, with the directorship of a national institute, and my own special department and personal researches in it, as well as a Royal Society secretaryship. In any case, I feel a retrospective pride in being reminded of the Society's responsibility for so supremely good a recommendation; for Gibson, until his all too early death, was tireless in his devoted work for the Academic Assistance Council, and for the Society for the Protection of Science and Learning which was so early to succeed it. Equally well deserved is the tribute which Lord Beveridge pays to the constant interest and resourceful energy of A. V. Hill, one of the Royal Society's research professors, who became a vice-president of these organisations. Another stalwart I am proud to remember was Sir John Clapham, who had been a schoolfellow of mine and who did noble work, while he lived, as Chairman of the Allocations Committee. And when the work grew to dimensions demanding the services of a salaried secretary, an ideal one was found in Walter Adams, who resigned a pensionable academic appointment of equal emolument, to serve this charitable enterprise with its indefinite future; and he, in turn, found, in due course, an ideal and much-needed assistant secretary in Miss Esther Simpson, who, we must feel, helps to keep alive something of the memories of those days of harrowing appeal, and of heartwarming success in the response to it, by her devoted service now to the Society for Visiting Scientists.

It is good indeed that there should be a record of this human tragedy, and of the spontaneous effort of our own academic fraternity to mitigate the sufferings and deprivations of those academic victims of it who were citizens of Germany, and then of other countries, as these came in succession under the Nazi heel, or under the blighting influence of the Fascist infection. And not of these only. On page 100 of Lord Beveridge's book will be found the record of a meeting of the SPSL in October 1956, with Prof. A. V. Hill now in its chair, at which it appeared that the end of the need for its beneficent activities might well be in sight, with only one displaced savant still receiving support, and many former beneficiaries restored to pension rights in Germany. The division of the Society's substantial balance between the Royal Society and the British Academy, for purposes acceptable to the subscribers, was even under active discussion. And then, only a few days later, came news of a Soviet-supported attack on Hungarians of independent political opinions, and a renewed need to support displaced scholars and scientists, this time from universities and research establishments in Hungary. The need for defence of free learning is evidently not yet ended; this record of its beginning and its maintenance is still to be welcomed, and Lord Beveridge was certainly the man best entitled and qualified to write it.

Some readers, myself among them, may find the accounts in Chapter 4, of the experiences of some of the refugees, in and on the way to internment in 1940, rather tedious and, in any case, not very useful so long afterwards. After all, it was a time of desperate emergency and a large proportion of our own manhood was then being exposed to much greater hardships and dangers to its survival. Each reader, however, must form his own judgment of what is worthy of such permanent record. Every British reader, I think, will find reason for satisfaction and pride in the record on page 105, showing that, after the United States with 225, our own country stands far ahead of all others in the number of the displaced scholars and scientists, no less than 174, for whom it has been possible to find new and permanent opportunity here. And which of us does not know of shining examples, of the gain to the potentialities of Britain's own contributions to science and learning, due to this recruitment?

This is, indeed, a book which should be widely read.

H. H. DALE

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### Symposium on Nuclear Sex

By D. Robertson Smith, M.A., M.D., and William M. Davidson, M.D. (*London, William Heinemann Medical Books Ltd, 1958, 21s. net*)

The study of nuclear sex was initiated about ten years ago, when Barr and his colleagues discovered that a substantial proportion of the hypoglossal neurones of the cat were characterised by a portion of the chromatin distinct from the main mass, and present only in female animals. This sex chromatin characteristic of the female has since been observed in the cells of the skin, mucous membranes, and in the polymorphonuclear leucocytes of the blood, as well as in other somatic cells. At first, these observations were of greatest interest to the geneticists, who were mainly interested in the relationship of this sex chromatin to the chromosomes. However, it has been found that the somatic cells of a substantial proportion of non-fertile men with the testicular insufficiency known as Klinefelter's syndrome contained sex chromatin. The demonstration that this was absent from the cells of women with Turner's syndrome (ovarian agenesis or dysgenesis) has thrown new light on these conditions and on other sexual anomalies. It was clear that while the nuclear sex of the individual was decided at fertilisation, and the body conformation (phenotype) usually conformed to this nuclear sex, under rare circumstances a sex reversal could cause genetically male individuals to assume a normal female conformation and vice versa.

In the late summer of 1957, a symposium was held at King's College Hospital Medical School in London on this subject, and the list of participants reveals how the discovery, and its practical applications, have involved workers in anatomy, physiology, cytology, genetics, endocrinology, pathology, biochemistry, and even psychology. The present book is an account of these proceedings, the discussions after each contribution being recorded, and presented in detail. Prof. Barr has provided a brief introduction and a concluding section summarising the symposium as a whole. The symposium was held in three sections dealing with the genetics and cytological aspects of nuclear sex, the applications to problems of intersex and related states and the application of nuclear sex to the study of tumours.

The first section was under the chairmanship of L. S. Penrose. Slyzinsky of Edinburgh attempted to relate the presence of sex chromatin in only 60–80% of female cells to somatic inconstancy of the chromosome number. It became clear that technical difficulties are very probably responsible for the failure to detect chromatin in all female cells and for the detection of so-called sex chromatin in a minority of cells of male animals. Ford brought significant evidence that the number of chromosomes in man was forty-six and not the hitherto accepted number of forty-eight. Sachs made a valuable contribution on the genetic origin of sex anomalies, and felt that they could be classified according to whether they were due to gonadal abnormality as in ovarian agenesis and the Klinefelter syndrome, or to an abnormality of steroid synthesis as in the adrenogenital syndrome (in which there is excessive production of androgens related to a deficient production of cortisol by the adrenal), or to an abnormality of the tissue response, as in male pseudohaemaphroditism. The general discussion which followed this paper and others in the second section of the symposium under P. M. F. Bishop, revealed the need for revision in the nomenclature of human intersex. The final section dealt with the application of these findings to the study of tumours, particularly to teratamata.

Since the symposium was held, work has progressed rapidly in this field. In particular the incidence and heredity of the Klinefelter syndrome and other abnormalities of nuclear sex have been investigated in various populations, especially of institutions and mental hospitals. This book will be an absolute necessity to those concerned with this fascinating and rapidly developing field of knowledge.

C. H. GRAY

### Nautilus 90 North

By Cmdr William R. Anderson with Clay Blair jr. (*London, Hodder & Stoughton, 1959, 190 pp., 36 illustrations, 2 maps, 15s.*)

This book is a brief record of the voyage of the first nuclear-powered submarine across the top of the world under the Arctic ice. It is told by the commander, an officer of the U.S. Navy, with pride in his service, the branch he serves, his superiors, his fellow-officers and crew, and especially his ship—the *Nautilus*.

But this report of an epic and historic event is very much an understatement. This is simple to understand. Cmdr Anderson is a young (38) naval officer who has devoted the past seventeen years to the submarine service. Since June 1957 (after a year with Admiral Rickover, in his Nuclear Reactors Branch) he has been in command of the *Nautilus*. His approach to and achievement of the magnificent voyage (as is his report) is that of a naval officer, schooled in the submarine service, trained intensively in nuclear reactors, and exposed to some aspects of the history and geography of the Arctic. The understatement is caused because Anderson is not an Arctic geographer, a naval historian, or an oceanographer.

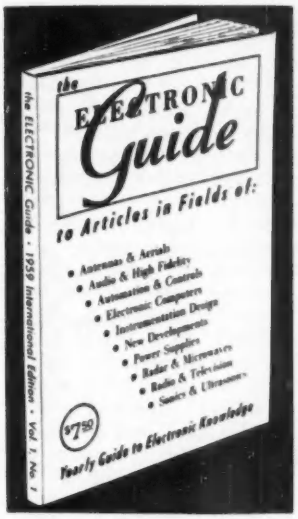
The story opens with the tension of awaiting final orders to execute the operation of the transpolar under-sea mission (Operation Sunshine). Anderson then flashes back to his interview with Admiral Rickover, and from then on the chronology includes his assignment to Nuclear Reactors Branch of the Naval Department, description of the *Nautilus*, its crew, its preliminary under the ice probings off the Atlantic side, preparations for the big jump from Pacific to Atlantic, and finally the trip itself.

Throughout, references are made to Dr Waldo Lyons, physicist in charge of Submarine and Arctic Research Branch of the United States Electronics Laboratory at San Diego. The full story of the contribution of Dr Lyons has yet to be told. For the scientist this story will be the most exciting.

Anderson's presentation of the background of Arctic information is weak. One cannot reach expertness by several months' library research, no matter how intense. The *Fram* forced its way into the ice-pack deliberately to study polar drift. It was not by accident or mishap (the late Harald U. Sverdrup was the scientist aboard). The *Sedov* became ice-locked without planning to do so, and the Russians then exploited the opportunity for study. Operation Highjump (I and II) took place in the Antarctic, not Arctic. Sir Hubert Wilkins's attempt at submarine exploration under the Arctic ice was briefly noted, but many exciting bits written by him and his colleagues in *Under the North Pole* are neglected, as, for example, that the first proposal for use of submarines in polar exploration was made by Rev. John Wilkins in 1648 (Bishop Wilkins of Chester, an ancestor of Sir Hubert). Nor is reference made to Stefansson's first modern proposal for under-sea transpolar navigation in his prophetic *Northward Course of Empire* (1922).

The story of the trip itself is intensely interesting yet told with a quiet undertone best understood from the author's own phrase, "ours was a world of supreme faith, faith in instruments, faith in the laws of physics, faith in each other and faith in Him who guided our destiny in the unknown seas ahead". All in all, this is a magnificent story, a tribute to the men of the U.S. Navy, whose role in Arctic exploration includes the achievement of the Pole by Lieut Robert E. Peary by sledge in 1909; by aeroplane in 1926 by Lt-Cmdr Richard Evelyn Byrd and Floyd Bennett, and now by Submarine Cmdr Anderson, his ship the *Nautilus*, and his crew.

M. C. SHELESNYAK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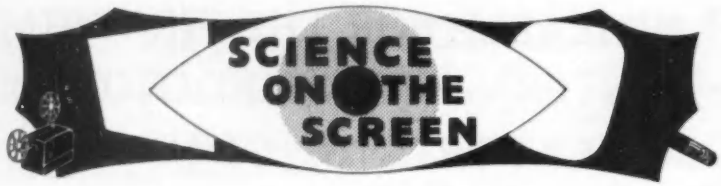


**Science Television in August**

Under the title "Science Television in August" one is sorely tempted to parody the schoolboy's story about snakes in Patagonia and just write, "There was no science television in August", and leave it at that. It was hard to find anything at all remotely connected with science. I am told that "Press Conference" on BBC (August 21) was devoted to grilling Sir Christopher Hinton about atomic energy, but then the content of Press Conference is not advertised in advance, and your hapless reviewer must needs miss this lone item. He gathered, however, that in any case the discussion was economic rather than scientific. Patrick Moore gave his monthly talk to children, "Seeing Stars", on the same date, and having said this, we virtually conclude the survey of a miserably inadequate scientific content for a whole month on BBC.

The broadcasts on ITV were not much better. For months and months we have now been able to find nothing scientific on the commercial channel other than the Sunday afternoon item, "It Can Happen Tomorrow", designed by T. Lingwood, produced by M. Style, and conducted, week after week, by Gerald Leach. The ambitious, extensive content (everything scientific is attempted) begins to become only too naturally a severe strain for one man to bear, yet Mr Leach manages, though he does show occasional signs of exhaustion. Quite apart from this, the Sunday, August 23, broadcast was poor television because from the beginning to end it was merely a twenty-minute piece of professional film about high-speed flight and the reason for the delta wing. Admittedly, at five-minute intervals the film was cut for Mr Leach to speak a few words. Finally, it was not a particularly good film, or maybe there were too many cuts in the broadcast version. For although it was quite technical in parts, there was much that should have been explained but was not. It was taken for granted that the viewer knew what a wind-tunnel was, how it worked, and why, that terms like "shock-stall", "ram-jet" needed no further explanation, and so on. This fault of using technical jargon has almost been cured in live TV broadcasting, but then this was film and not live TV, and we do not know how much of the original was cut to trim to the time available.

The absence of science broadcasting during the summer months is rather curious. It surely does not mean that the broadcasting authorities think there is no audience. If so, why is a high standard, both in quantity and quality, still maintained in opera, drama, music, variety, and so on. Why penalise science? Especially when the summer vacation is just the time when so many university scientists might well be induced to prepare a broadcast. Producers would do well to recall that the main scientific publicity event of the year, the British Association, is itself always held during university vacation.

It may be a wicked thought, but if it does happen to rain whilst one is at the seaside, there will result a big captive audience round the hotel television set. Since rain on holidays is not quite so rare an event in these isles, producers can fairly reasonably gamble on quite an audience during August. S. TOLANSKY

**The Opening of a Ming Emperor's Tomb**

When the pyramids were opened in Egypt, participation in the discovery was restricted to those who actually excavated. When a recent and comparable event took place in China, the opening of the tomb of a Ming Emperor, it was possible to make a coloured film of the various stages, thus conveying to a bigger audience the excitement of the work.*

In 1957, Chinese archaeologists decided to attempt an excavation of the tomb of Wan Li (1573–1620), one of the later kings of the Ming dynasty. It was situated in a valley not far from Peking where twelve other members of the dynasty also have their mausoleums. It is indeed remarkable that this tomb escaped the frequent visits of grave robbers, a species of "diggers" known not only to China but to all other regions of the world where graves are known to contain valuable objects. This is all the more surprising since the Ming tombs are not only indicated by fine pavilions in the best architectural style of the period, but the Ming chronicles give details regarding the construction and cost of the tombs. This good fortune attending the tomb of Wan Li was probably due to the fact that the entrance to the tomb, an underground passage, began at a point above ground which was not known.

It was the discovery of some loose bricks on the site of the tomb which provided the first indication of where the initial trench should be dug. This was followed by the successful location of an inscription pointing to the actual passage. The removal of some bricks of the outer wall, gave access to the vaulted entrance, from where a beautifully carved marble door led to the antechamber. Happily for the excavators the door panels were slightly ajar, so that it was possible for them to be carefully pushed open.

A similar doorway led to the sacrificial chamber, and at right angles to this was the burial chamber of the Emperor. Halfway down its length, the sacrificial chamber opened on to two corridors, one on each side, which terminated in the burial chambers of the two Empresses. In fact these two chambers were never used since both the Empresses predeceased Wan Li, and were consequently buried in the vault built for him. The two subsidiary burial chambers had separate entrances above ground, which was customary in the construction of such tombs; the idea was that should the Empresses outlive their husbands, the burial chamber containing the coffin of the Emperor should not be disturbed when the wives were eventually buried.

The burial chamber of Wan Li was the most interesting room and had the richest collection of objects in the entire "underground palace". The spacious feeling of the grey limestone appears to have been off-set by the red-lacquer coffins. The three coffins contained the bodies (now merely skeletons), which had been packed round with rolls of finely woven silk. The coffins of the women contained various accessories such as elegant head-dresses, jewels, robes of various kinds, toilet articles, and a number of objects of daily use, a wash-basin and ewer, bowls, chopsticks and spoons. But the coffin of Wan Li revealed objects of breath-taking magnificence. The most striking of these were his crown, worked in gold mesh and delicate engravings, carved jade bowls, a jade ewer and jade girdles of the best workmanship, ritual tablets, and some blue-and-white porcelain ware, for which the Ming period is famous.

Grave furnishings outside the coffins both in the burial chamber and the sacrificial chamber were largely ritual objects, such as special vases of the blue-and-white porcelain, red-lacquered wooden boxes containing seals and tablets, incense burners, beakers and other objects for ceremonial use. Armour, consisting of a richly decorated iron helmet, a coat of iron, a sword, a composite bow and iron-tipped arrows, was also found, and is thought to have been the personal armour of the Emperor.

Ming, meaning "bright", was certainly one of the more spectacular periods of Chinese history. Ming ascendency, from

* *Underground Palace* is available from Contemporary Films, London.

1368–1644 saw considerable luxury at the Chinese court, much of which is preserved to this day in tombs similar to those of Wan Li. The Chinese archaeological department may be congratulated on its decision to repair the tomb of Wan Li, provide it with adequate lighting arrangements and re-install the objects found in the vaults, thus making it a far more vivid museum for the lay visitor than any brick or cement building above ground. R. THAPAR

**ISFA Research Film Conference**

This year's annual conference of the ISFA Research Film group was held in Utrecht and came closer than it ever has to fulfilling its function. I. Varrossieau and P. M. B. Jannsen were excellent hosts and gave invaluable help to delegates.

Perhaps the outstanding impressions your reviewer took away were from Dr Thiery's film from Paris, a cytological study of the cytoplast which was made with great skill, patience, and knowledge; Mr Duncan's colour study of a small-scale operation where a commentary was subsequently added by the surgeon; and the four short films made by Dr Rieck of Göttingen—*Mechanical Engineering* (shock absorbers in vehicles), *Electrical Engineering* (transformers in short circuit and shorts of 120 msec. duration), *Mining* (drill movements in automatic drill tools, 3000 frames/sec.), and *Railway Engineering* (rail transfer to concrete sleepers).

This year's programme covered a much wider field than on previous occasions, as can be seen by the above headings. There were also many discussions, one of the main topics being the exact definition of the term "Research Film". J. HORNE

**A Two-year-old Goes to Hospital**

This film, produced by James Robertson, was originally released in 1952. It was a 45-min. documentary study of the behaviour of a young child separated from her mother through hospitalisation, and showed the consequent psychological damage to the child. This version contained detailed time-sample material for the benefit of the specialised student of child behaviour.

A new abridged 30-min. version (16 mm., black and white, sound) is now available. This version, intended for tutors in medical and nursing schools, omits the time-samples. It may also be shown to universities and lay groups. The illustrated guide to the film (Robertson, J., "A Two-year-old Goes to Hospital", Tavistock Publications Ltd, 1959, iv+ 24 pp., 3*s.* 6*d.*) has been revised and brought up to date.

Mr Robertson has also produced *Going to Hospital with Mother* (1958), a companion-piece to the first film. The two films will be discussed in greater detail in a forthcoming issue of DISCOVERY.

**Astronautical Films**

At the Tenth Congress of the International Astronautical Federation, which was held recently in London, a number of interesting films were presented. General Electric presented two taken from the nose cones of rockets launched over the Atlantic range; they were 16 mm., silent. The first one, taken in July 1959, was concerned with the flight up to an altitude of 350 miles and showed the camera locking on to the horizon and then seeking the sun. The second film, made on August 21, 1959, dealt with a flight to an altitude of 750 miles, and showed the Caribbean Islands, and cloud covering the South American continent.

Avco Corporation showed a film, *Down to Earth*, dealing with the heat generated by the re-entry of rocket nose cones; it was a popular type of film.

American films showing the launching of *Pioneer I* and *III* were also shown.

# LETTERS TO THE EDITOR

***Birthright***

Sir:

I believe it would be unfortunate if the review of *Birthright* went unchallenged, as it brings up points of wide importance. In general, the film is criticised for not being four or five quite separate and different films. Obviously, the Family Planning Association should have a whole programme of films, and if we were members of a more enlightened society the money would be readily available. The ideal film, aimed solely to explain to childless couples how they might be helped, would be different and yet still possibly not ideal. However, I like to think that there may be virtues in our difficulties and in the very fact that most of our films are seen by many different sorts of people and must carry various kinds of information. Free Cinema won for itself the right to make films with a limited aim and a minimum of information, and it was not sheer coincidence that so many of them were patronising. *Birthright* is in some ways a complete contrast to Free Cinema and yet beats nearly all of it at its own game. It is the great achievement of Sarah Erulkar that she brings across her characters as warm, human people, and at the same time gives us a great deal of information. This is particularly so with one of the doctors, and it is far more relevant to the success of the film than the poor, but honest state of the consulting rooms. Personally, I found the discussion at the end was overloading the film, but I do think that it remains a considerable achievement and it would be a thousand pities if it was overlooked because a critic found that it did not fit in with his preconceptions. BILL MASON

*London, N.W.*

***Samba in the Air***

Sir:

Two inadvertent misrepresentations were made in the article "Samba in the Air—a Film Case History", published in the April 1959 issue of DISCOVERY:

(1) The producer and director of the film was Dr Gaetano Petrosemolo of Piazza di Siena, Rome—author of other documentaries in colour which have received several prizes—and not Mr Ugo Giacomazzi, who is the Director of Music.

(2) The film *Samba 8 ala rotante* was produced by Dr Petrosemolo with the sole intention of providing amusement and interest to the cinema-going public, and for no other purpose.

Because I was attracted by the beauty of the film and by the clear lessons on piloting helicopters contained in the centre part, I tried to use it also as an instructional film for the benefit of students. The results obtained were identical to those mentioned by L. Gould-Marks, because the dance of the helicopters which follows the lessons in piloting was far too amusing and exciting, diverting the attention of the students. It is only fair to point out that the producer, Dr Petrosemolo, never intended the film to be put to this use.

Recent experiments have since shown that inverting the two parts of the film, that is, allowing the film to end with the lesson in piloting or repeating this part after a pause, the instructional value of the film is found to be high.

LT.-COL. FILIPPO GRECO

*Ministry of Defence—Air,*
*General Secretary's Office,*
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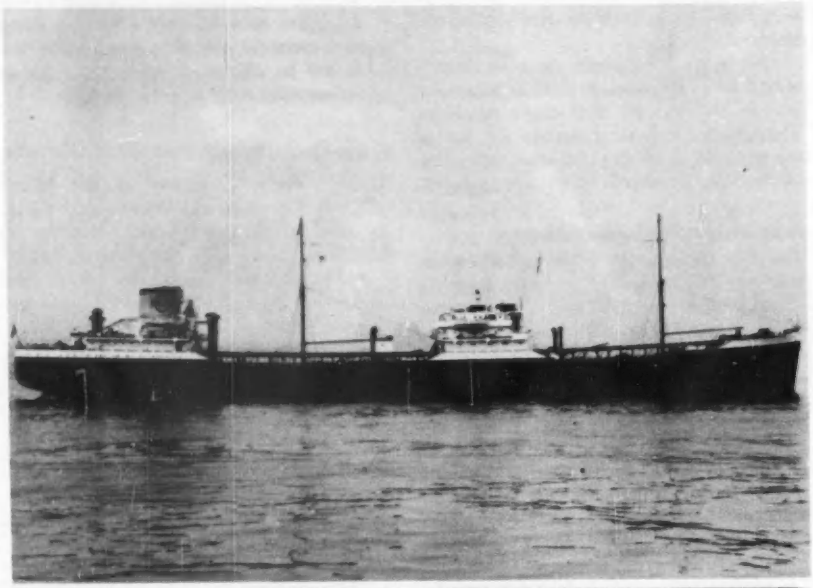

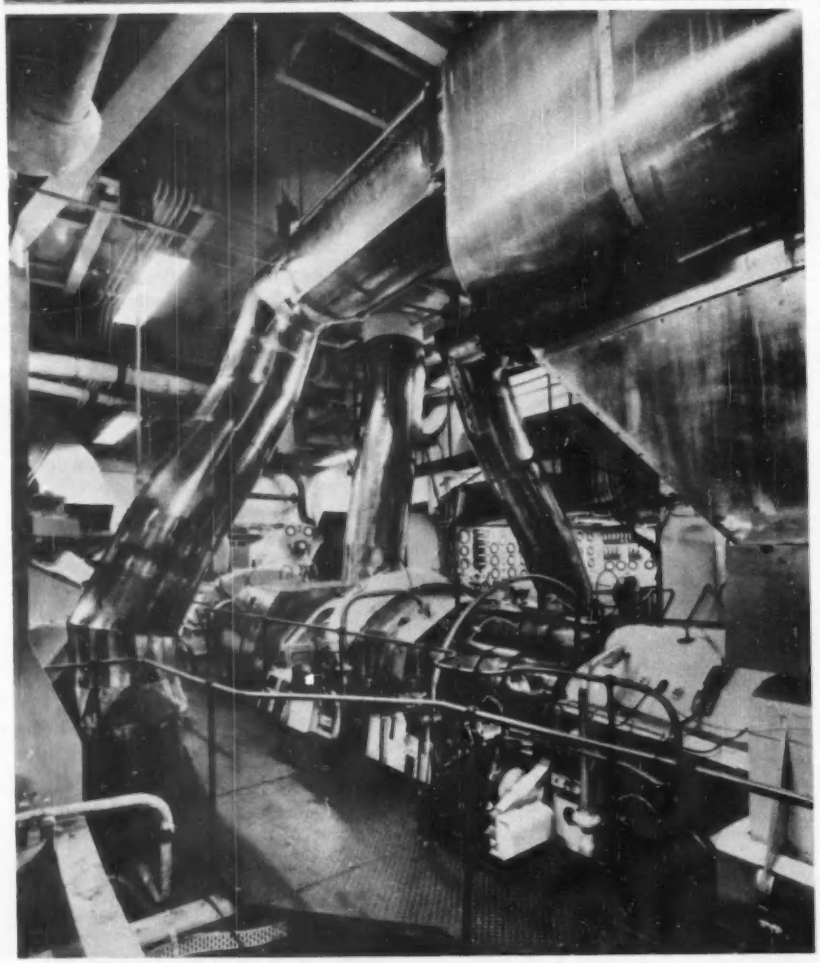

**Reith Lectures: The Future of Man**

Prof. P. B. Medawar, C.B.E., F.R.S., will give this year's Reith Lectures. He has chosen as his theme, "The Future of Man", and the broadcasts will be heard at 9.15 p.m. on six successive Sundays, from November 15 to December 20, in the BBC Home Service.

The recent centenary of Darwin's "Origin of Species" revived memories of the great Victorian controversy which it stirred up. What worried the critics and contemporaries of Darwin was probably not so much the general theory of evolution as what it implied about the lowly animal origin of man. They were profoundly disturbed by the suggestion that man was to be classed with the animals, subject to the same impersonal laws of natural selection. A recent biographer has remarked that Darwin's opponents seemed more preoccupied with the past, his friends more interested in the future.

In the past hundred years much evidence has accumulated in support of Darwin's hypothesis, and the lectures will give listeners a picture of the present state of knowledge of the biological status of man. The mechanism and peculiarities of human evolution will be discussed. But, especially, Prof. Medawar will be concerned with the question of the possible future evolution of our species and the forms this could take. This will inevitably involve an examination of the evolutionary forces acting now, including the often unforeseen genetic effects of cultural patterns, economic and social policy.

Prof. Medawar has been Jodrell Professor of Zoology and Comparative Anatomy at University College, London, since 1951, and was formerly Professor of Zoology in the University of Birmingham. He was educated at Marlborough and Magdalen College, Oxford. While at Oxford he began his research work in the laboratory of Sir Howard Florey (of penicillin fame) and ultimately became a Fellow of his college. He has made significant contributions to the scientific study of growth, ageing, and immunity.

**Louis Rapkine Association**

The British section of the Louis Rapkine Association held its fourth Annual Meeting at the Ciba Foundation in May. Dr R. Vilain, Chirurgien Assistant des Hôpitaux de Paris, gave a talk, illustrated

(*Top left*). *Auris*, the 12,000-ton Shell tanker which has been fitted with gas-turbine machinery and has successfully completed sea trials. She is the first tanker to be driven entirely by a gas turbine.

(*Bottom left*). *Auris*'s 5500-h.p. gas-turbine machinery.

by slides and films, on "Plastic surgery and problems of cicatrisation".

The Association was formed in 1956 and membership is open to French and British doctors, and research workers in the biological sciences, who have held grants to carry out research in each other's countries. The Association is named after the French biochemist Louis Rapkine who died in 1948.

It was announced at the meeting that the Cross of "Chevalier de la Légion d'Honneur" had been awarded by the French Government to Dr G. E. W. Wolstenholme, O.B.E., Director of the Ciba Foundation, in recognition of the work he is doing for international co-operation in medicine and science and more particularly for Anglo-French collaboration.

**IFORS**

At the beginning of this year a new organisation was inaugurated to strengthen one of the youngest branches of science. The International Federation of Operational Research Societies came into existence on January 1 with as its objects "the development of operational research as a unified science and its advancement in all nations of the world". The initial membership of IFORS consists of the Operations Research Society of America, the Operational Research Society (United Kingdom), and the Société Française de Recherche Opérationnelle. Membership is open to other national societies whose primary object is the advancement of operational research and whose membership includes qualified scientists working in this field.

The Federation will be governed by a Board of Representatives, one representative coming from each member society. According to the statutes, the voting power of each representative is proportional to the square root of the size of the membership, a formula designed to give the right weight to size.

One of the first activities of IFORS will be to sponsor the second international conference on this subject, following the successful first conference held in Oxford in 1957. The second conference is provisionally planned to take place at Aix-en-Provence, in southern France, in early September 1960.

Sir Charles Goodeve has agreed to act as the first Secretary of IFORS, and Mr Donald Hicks as Treasurer. The address of the Federation in the first instance will be 11 Park Lane, London, W.1.

**Foam Speeds up the Healing of Wounds**

It is expected that a plastic powder, produced by disintegrating carbamide foam into minute particles, will soon be introduced for the treatment of wounds. The particles are very finely textured and are shaped like minute lamellae; they exhibit a surface area forty times that of the same quantity of starch and twenty times that of talc.

The new powder does not irritate the skin, and adhesion is good. It absorbs a relatively large amount of water (one gram of powder can bind two grams of water). Further, it prevents the dressing from sticking to the wound. The solid foam may also be sliced into thin layers and placed directly on the wound, in which case the healing process is speeded up.

Other new medical uses of plastics include the replacement of bones, joints, and arteries. They also serve as materials for sutures, netting, tapes, corsets, and corrective collars.

**Unknown Forces Along Earth's Axis**

At a recent meeting of the U.S.S.R. Geographical Society, Prof. Nikolai Kozyrev of Pulkovo Observatory, who recently photographed a volcanic eruption on the Moon, made a report on his discovery of previously unknown forces acting along the Earth's axis of rotation.

As early as 1949 Kozyrev, using astronomical photographs, measured the hemispheres of the rapidly rotating planets Jupiter and Saturn. It turned out that the northern hemispheres of these planets, like the northern hemisphere of the Earth, are more compressed than the southern hemispheres.

Kozyrev developed an original system of mechanics on the basis of which he concluded that special forces act along the axes of rotating bodies.

Kozyrev established the existence of these forces on the surface of the Earth as a result of experiments carried out at Pulkovo Observatory. A special method of measuring these forces, which, he suggested, was also applied beyond the Arctic Circle and in the Crimea. The measurements confirmed the scientist's conclusions about unknown forces actually directed along the axis of the Earth's rotation and about the dependence of those forces on geographical latitude.

Kozyrev considers that in the polar areas these forces must change so considerably that their magnitude can be used to determine the latitude of a given place with a high degree of accuracy. This might be useful for determining the position of drifting scientific stations in the Central Arctic basin.

**U.S. Army Presents *Explorer I* Replica to Smithsonian Institution**

Secretary of the U.S. Army, Wilber M. Brucker, presented a replica of the Army's *Explorer I*, the first United States earth satellite placed in orbit, together with its Jupiter-C carrier missile, to the Smithsonian Institution on January 31. Presentation of the full-scale aluminium reproduction of the space vehicle made exactly one year after the Army's huge missile successfully launched *Explorer I*.

The ceremonies, were attended by many prominent civilian and military officials who were instrumental in developing the satellite and missile.


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Ten lectures in the Beveridge Hall, Senate House, W.C.1, beginning Monday, October 5, at 7.15 p.m. Various lecturers.
3. MODERN VIEWS ON ANIMAL BEHAVIOUR
Ten lectures by Dr J. D. Carthy for graduates in biology, at Chelsea Physic Garden, beginning Wednesday, October 7, at 7 p.m.
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Twenty-four lectures by Dr W. E. Swinton, at the City Literary Institute, beginning Tuesday, October 6, at 7 p.m.
5. BRITISH WOODLANDS
Twenty-four lectures by H. L. Edlin and Dr P. J. Newbould, at Chelsea Physic Garden, beginning Monday, October 5, at 7 p.m.
6. SURVEYING TECHNIQUES FOR GEOMORPHOLOGY
Twenty-four lectures by Dr J. C. Pugh, at the City Library Institute, beginning Thursday, October 8, at 7.30 p.m. Practical work on Hampstead Heath will be included.

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# Take a moment, dear Reader

. . to look at the table of contents of the October issue of SCIENTIFIC AMERICAN:

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| The Transplantation of the Kidney | *by John P. Merrill* |
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| Life and Light | *by George Wald* |
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To the scientific community of the United Kingdom, SCIENTIFIC AMERICAN is already well known as the monthly magazine that covers all departments of science. In the words of our distinguished British contemporary, *Nature*, "... through sound policy, good editing and attractive presentation this journal has won the high regard of scientists and laymen alike for its excellent interpretation of scientific discovery and advancement."

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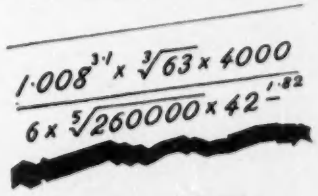


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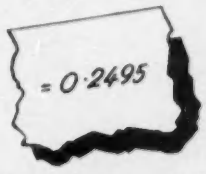


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Many new metals discovered in the past have been put aside as ' curiosities ' — difficult to refine, difficult to work, and offering no obvious advantages over well-established metals. But in this atomic age nuclear engineers are demanding for their reactors metals with combinations of properties never needed before, such as compatibility with uranium fuel, the ability to withstand corrosion from very hot liquids and gases, and low absorption of neutrons.

One of the metals that has been taken off the laboratory shelf and put to work in this way is zirconium. It has been known to metallurgists for 150 years and its ore is found in beach sands throughout the world, but its refining, melting and working present great problems. I.C.I. scientists and technicians have overcome the melting and working problems to such effect that half-ton ingots of zirconium and its alloys are now being produced as a matter of course, enabling this once-rare metal to play an indispensable part in Britain's nuclear power stations.

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ICI